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ORIGINAL ARTICLES.

I.—Upper Cretaceous Terebelloids from England.[1]

By Dr. F. A. Bather, M.A., F.R.S., F.G.S., etc.

(PLATE XXIV.)

In April, 1879, William Davies published in the Geological Magazine (n.s., Dec. II, Vol. VI, pp. 145–8) a paper on "Some Fish Exuviæ from the Chalk, generally referred to *Dercetis elongatus*, Ag.; and on a new species of Fossil Annelide, *Terebella Lewesiensis*". Herein he discussed certain longitudinal or tubular agglomerations of fish-debris, originally named *Muræna* (?) *Lewesiensis*, by G. A. Mantell, but subsequently assigned by L. Agassiz to the fish described by him as *Dercetis elongatus*. References to the various papers and books in which these remains had been mentioned will be found in the paper quoted. From his profound knowledge of fossil fish Davies was able to show that these agglomerations contained the remains of more than one species of fish, and he considered that the fragments had been collected and affixed to their tubes by annelids allied to the modern *Terebella*. It is well known that some living species of that genus have similar tube-building habits, so that the suggestion made by Davies has been generally accepted, and the specimens in the British Museum on which he based his conclusions have since then been labelled *Terebella* (?) *Lewesiensis* Mantell sp.

The object of the present note is to make known some slight additions to our knowledge, and to discuss one or two points in the paper by Davies.

The specimens described by Mantell and Agassiz and the majority of those studied by Davies were composed of the debris of fish. In these specimens Davies pointed out diverse individual variations: some are of small scales, with few or no bones [B.M. 25875, 25876]; others of large or small scales associated with numerous small bones [B.M. 58259]; others, again, have assembled long fin-rays "arranged fairly in the direction of the long axis of the specimen", e.g. that figured in Dixon's *Geology of Sussex*, pl. xxxiv, fig. 5 [B.M. 25942], and the specimen 14 inches long, to which Davies specially referred [B.M. 58261]. The variation, however, is considerably more than this, for we now know of specimens from the Cretaceous rocks of England that have a tube of quite other composition. One specimen [B.M. A 1583], from the Cenomanian Grey Chalk of Folkestone,

[1] Published by permission of the Trustees of the British Museum.

appears to represent a tube composed of the small ossicles of starfish and brittle-stars. Other specimens, recently detected by Dr. Marie C. Stopes in the course of her work on the Catalogue of Cretaceous plants in the British Museum, have a very distinct tube composed of leaflets and fragments of bark of some coniferous tree or trees, either pine or fir. Finally, there are specimens which, in the words of Davies, "admirably show by impression the membranous or horny structure of the tube," yet "bear no indication of the attachment of any foreign substance".

Before entering on any speculation as to the specific distinctness or identity of these various forms, it may be well to set forth such definite facts and natural conclusions as are not already contained in the valuable paper by Davies. The tubes of different composition will be dealt with in order.

Tubes of Fish-debris.

'*Terebella*' *lewesiensis* (sensu stricto).

Diagnosis.—Tube of fish-debris, with diameter from 1 to 3 cm., and with a possible length of 34 cm. or more.

Horizon.—Cenomanian to Senonian.

Locality.—South-East England generally, so far as recorded.

Lectoholotype.—B.M. 4152, ex Coll. G. A. Mantell.

This appears from the British Museum specimens to be common in the Cenomanian zone of *Holaster subglobosus*, and the nature of their matrix suggests that Mantell's figured specimens probably came from this zone. He gives as localities "Upper and Lower Chalk, near Lewes and Brighton" (*Foss. S. Downs*, p. 233). The matrix of the figured specimens suggests Lewes rather than Brighton. Since Mantell says (loc. cit.) that his "Tab. xl, fig. 2, represents the usual appearance of these fossils", I fix on the original of that figure (B.M. 4152) as lectoholotype. Mantell says that specimens "occur abundantly in the Upper chalk, and occasionally in the siliceous nodules". All these may have been formed by the same species; one cannot distinguish them.

In addition to a number of specimens labelled "Kent" or "Sussex", or merely "S.E. England", there are in the British Museum representatives of this typical form from the following more precise localities:—

Folkestone. Chalk Marl, Cenomanian. [58255.]
Hamsey, Sussex. "Grey Chalk Marl," Cenomanian. [4154.]
Cowslip Pit, near Guildford. Cenomanian. [A 1571/2/3.]
Burwell, Cambridgeshire. Greyish "Lower Chalk", Cenomanian. [58256.]
Aylesford, Kent. Cenomanian (?). [23158.]
Near Lewes. "Lower Chalk," Cenomanian. [4124, 4148, 4151, 4152, 25942 (?).]
Near Lewes. "Upper Chalk." [4122, 4156, 58259, A 73.]
Davis' Shalford Pit, near Guildford. Upper Chalk, Senonian. [A 1627–A 1634.]
St. Giles' Gates, near Guildford. "Upper Chalk." [58258.]
Chatham. "Upper Chalk." [A 1636.]

It will be noted that the Turonian is, so far as our definite information goes, unrepresented in this list. In March, 1880,

however, I obtained a specimen from the *Terebratulina* zone near Winchester, duly exhibited before the College Natural History Society as 'a fossil fish'. Mr. T. H. Withers tells me that in Oxfordshire and Surrey the species is common in that zone, as also in the *Rhynchonella Cuvieri* zone of Surrey.

Although this fossil is not noticed by name in his papers on the Chalk, Dr. A. W. Rowe kindly permits me to give as his experience that it occurs in every zone of the White Chalk. It is, he says, rare in the zones of *Belemnitella mucronata* and *Rhynchonella Cuvieri*, but especially common in those of *Marsupites* and *Micraster cor-anguinum*; it is also common at Dover in the zones of *M. cor-testudinarium* and *Holaster planus*.

That these bodies were tubular was maintained by Davies, on the evidence of specimens, not more precisely designated, in the British Museum. Apparently the tubes have sometimes been flattened, at least in part [23158]. Frequently they have an elliptical section, probably due to post-mortem compression; thus we find diameters of 18 and 12 mm. [A 1627], of 20 and 14 mm. [25876], of 22 and 15 mm. [58262]. But that the tubes had a moderate amount of rigidity may be inferred partly from the fact that the specimen last mentioned has a core of flint, partly from specimen A 1629, in which a *Spondylus* valve lying alongside has been broken by pressure against the tube.

Considerable variations in the apparent diameter of the tube (e.g. 30 and 20 mm. [A 1632], 20 and 13 mm. [25943]) are probably due to crushing; and this cause may also account for the appearance of a short branch about the middle of the length (16 cm.) preserved in A 1573, where the width at one end is 21 mm. but close to the branch only 12 mm. There is a similar appearance in A 1567, made of conifer leaflets.

The maximum length of these tubes was given by Mantell as 2 feet, but Davies maintained that they might have been longer "as no specimen with the extremities entire has yet been discovered". I don't quite see how one is to decide whether an extremity is entire or not, except by knowing that a piece was left behind in the quarry, and certainly this has not been the case with all specimens. The longest specimen in the British Museum is that figured in Dixon's *Geology of Sussex*, pl. 34, fig. 5 [58261]; it is 35 cm. long (a little less than the "fourteen inches" assigned to it by Davies), and 35 mm. wide; the included fin-rays, according to Davies, "exceed two inches in length," and some are actually 10 cm. long, nearly 4 inches. The horizon and locality of this specimen are unknown. The longest specimen from the Mantell Collection [4126] is 29·5 cm. long and 20 mm. wide; it is said to be from the "Chalk, Lewes". These measurements do not follow the curves of the specimens. Davies speaks of the "comparative straightness" of the tubes, but the longer specimens, at least, are always curved and often markedly sinuous; thus, A 1629 is like an elongate *f*, with an approximate length of 20 cm. and a diameter of 16 mm., and shows no obvious signs of being incomplete.

The width of the tubes can rarely be measured with great exactness; as already mentioned it often varies, and is probably always exaggerated

by crushing, especially in the larger specimens. In the following cases the maximum width observed is the one given. Beginning with 10 mm. (3 specimens), this maximum passes through 13 mm. (1), 14 mm. (1), 15 mm. (3), 16 mm. (3), 17 mm. (2), 18 mm. (4), 20 mm. (13), 21 mm. (1), 22 mm. (3), 23 mm. (1), 25 mm. (2), 28 mm. (1), 30 mm. (4), up to 35 mm. (4): total, 46 specimens. It will be observed that by far the largest number of specimens is associated with the width of 20 mm., and that there are 17 specimens below this and 16 above it. Making allowance for the exaggeration by crushing in the widest specimens, we infer that this width of 20 mm. is almost exactly the mean, and that the natural limits of the species are about 10 mm. and 30 mm. In the circumstances one would perhaps not expect any relation between the length of the specimens and their width; certainly no such relation is perceptible. Neither is there any relation between the width of the specimens and the horizon from which they come.

A specimen from the Gault, though also composed of fish-remains, differs from all the Chalk specimens in its markedly greater width. Since there is no reason for regarding this as due to exceptional crushing or any peculiar conditions of preservation, and since it is improbable that a species living in Gault mud continued unchanged into the Chalk ooze, it seems advisable to establish a new species—

'*Terebella*' *lutensis*[1], n.sp.

Diagnosis.—Tube of fish-debris, with diameter over 4 cm. and with a possible length of 29 cm. or more.

Horizon.—Albian: Gault.

Locality.—Eastbourne, Sussex, so far as recorded.

Holotype.—Brit. Mus. A 23, ex Coll. John Morris. (Plate XXIV, Fig. 6.)

The exact measurements of the holotype are 29 cm. × 4·5 cm. × 2·4 cm. The wall is thick and has a coarse appearance, due to the large size of the scales and bone-fragments and their irregular arrangement.

Tubes of Plant-debris.

Of these there are in the British Museum seven specimens. Two of them [A 1565, A 1566] from "Dorking Pit", Surrey, are probably of Cenomanian age from the zone of *Holaster subglobosus*; one [A 1640] is from the "Upper Chalk" of Broadstairs, Kent; of the others [A 1567–A 1570] from the Chalk, probably of Sussex, the precise localities and horizons are unknown.

There can be no question but that these bodies are of the same nature as the tubes made of fish-debris, and many of the remarks concerning those are equally applicable to these specimens. None of them, however, exceeds 16 cm. in length [A 1640]. The widths range from 17 to 35 mm. Reference has already been made to A 1567, which has apparently a slight branch; the tube is 7·5 cm. long, 23 mm. wide at one end, and only 11 mm. wide beyond the apparent branch—measurements which confirm the view that the appearance is due to crushing.

[1] Dwelling in clay.

There is slight variation in the character and arrangement of the leaflets that compose these tubes. Thus in A 1568 (Fig. 8) the leaflets have a length of 20 mm. or a little less, and cross one another irregularly, but are more or less longitudinally placed; in A 1569 the leaflets are 14 mm. or less in length, and cross irregularly; in A 1570 they are about 10 mm. long, irregular, but tend to a longitudinal arrangement; in A 1640 they are 10 mm. or less in length and quite irregularly scattered; in A 1565 they are rather shorter and irregular, and are combined with fragments of bark; in A 1567 the leaflets lie somewhat longitudinally or at a rather regular angle, and there is in places an appearance as of two layers crossing; in A 1566 (Fig. 7) the leaflets are short, probably mixed with bark, and seem to imbricate irregularly.

These tubes have a rather straighter appearance than those of fish-debris; but this may be due to their less length. A slight curve is to be seen in A 1566, which is 10 cm. long. A 1640 is probably curved, but is much flattened, and its outlines are not clear.

As Dr. Stopes has kindly pointed out to me, J. Velenovský in 1885 figured fir-needles composing a similar tube in the Cretaceous Teplitz beds of Raudnic, Bohemia, and gave to them the name *Abies minor*.[1] It is not to be inferred that any of our specimens necessarily belong to the same species of worm as the tube figured by Velenovský, or that the plant-remains are identical with those described by him.

Tubes of Echinoderm-debris.

At present I know of only the one specimen previously referred to, namely A 1583 in the British Museum. This is composed of ossicles of Asteroids and Ophiurids. It comes from the Cenomanian Grey Chalk of Folkestone, Kent. Its length is 15 cm.; its width, 16 mm.

Tubes of this composition may be of more frequent occurrence than one might infer from their rarity in our collections. Assemblages of small Echinoderm ossicles do not, as a rule, appeal to the collector, unless the ossicles in themselves have some peculiar interest.

The Taxonomic Value of the Building Material.

Before proceeding to the discussion of those tubes in which no building material is obvious, we may pause to consider whether the difference of composition in the tubes already described indicates the existence of more than one species of Annelid. It may be that the worm merely seized on any appropriate fragment that changed to lie in its neighbourhood; or it may be that divers species selected each its own peculiar objects, as is the habit of various lowly animals in modern seas.[2] Either view may be supported by the described habits of modern Terebelliformia.

The process of tube-construction in *Terebella* and its allies was observed and described by Sir J. G. Dalyell (1853, *Powers of the Creator*, vol. ii, pp. 176–205), and Mr. Arnold T. Watson has given

[1] *Die Gymnospermen der böhmischen Kreideformation*, Prag, 1885; see p. 33, pl. viii, fig. 1.

[2] e.g. *Phorus agglutinans* covers its shell with extraneous objects; one form carefully using rocks is called 'the mineralogist', another selecting small shells is called 'the conchologist': this supposed *selection* may, after all, be due to the occurrence of shells in one locality and stones in another.—Editor.

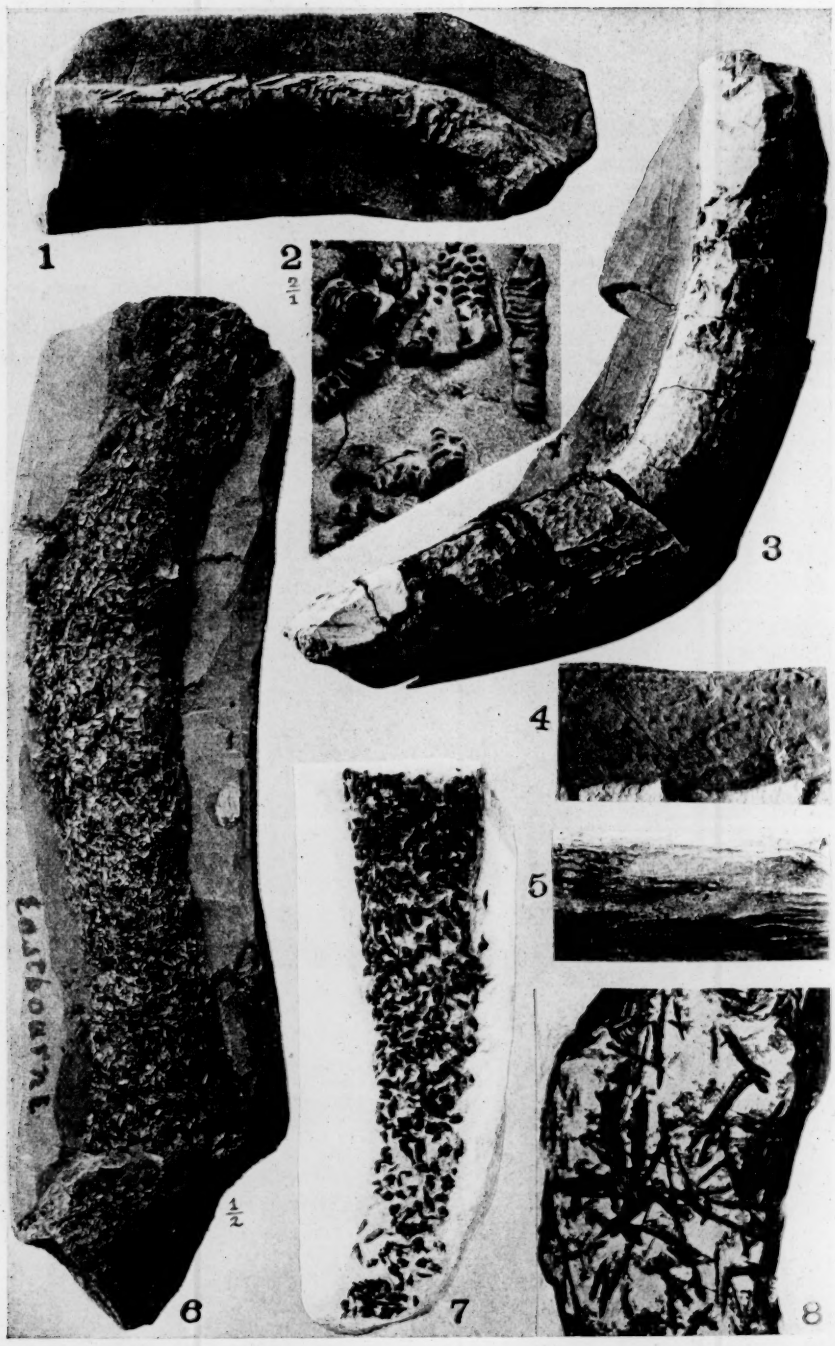
further details for a species of *Terebella* (Journ. R. Micr. Soc., 1890, pp. 685–9, pl. xiv). In January, 1894, Professor W. C. M'Intosh published a lecture "On certain Homes or Tubes formed by Annelids" (Ann. Mag. Nat. Hist., ser. vi, vol. xiii, pp. 1–18), summarizing *inter alia* the facts in his *Challenger* Report on the Annelida Polychæta (1885).

The evidence for selective faculty or habit, when presented by rare species known from only one or two localities, is of course unconvincing; but there are some fairly clear instances among species that are better known. Thus *Euthelepus setubalensis* seems to select hexactinellid sponge-spicules from the foraminiferal mud in which it lives (M'Intosh, *Challenger* Report, p. 466), and according to Dalyell (1853, p. 176), "The animals [of *Sabella alveolaria*] testify a decided preference on choosing the materials of their habitations. While always preferring sand and comminuted shell, pounded glass is sparingly and reluctantly employed, and unless for a few fragments, it is soon entirely rejected."

On the other hand, one and the same species is known to make its tube of different material according to circumstances. "Thus in *Northia* [sic] *conchylega*," says Professor M'Intosh (1894, p. 6), "the tube proper is, in the Zetlandic examples . . . strengthened externally by entire shell-valves, large fragments of the latter, pieces of sea-urchins and heart-urchins, or, in those procured by the *Knight Errant* in 608 fathoms in the Atlantic, of coarse gravel." Again, Professor M'Intosh (1894, p. 13) figures two similarly-shaped tubes of *Amphictene auricula*, one from shallow water, formed of sand-grains irregularly disposed, the other from deep-sea mud, built of sponge-spicules in regular layers. An example that has some bearing on the present case is *Nothria macrobranchiata*, M'Intosh (1885, *Challenger* Report, p. 322; and 1894, p. 6), dredged in green mud at 345 fathoms south of Yedo [Tokyo], Japan. This "utilized the long linear leaves of the pines swept down by the rivers, besides leaf-stalks and leaves, straws, stones, and fragments of echinoderms, to strengthen its tube of greyish mud". In the specimens described and figured the pine-needles were arranged longitudinally to serve as a sort of scaffold, only one or two being used.

Notwithstanding the curious mixture of materials occasionally observed, one does get the impression that the tubes are to some extent characteristic of the various species. The character, however, seems to reside as much in the size of the fragments as in their material. There are also differences in the relative amount of secretion contributed by the worm itself, and in the arrangement of the foreign particles, as well as obvious differences in the actual size of the tube.

Reverting to the Cretaceous tubes, we note that the materials, though diverse, are not mixed. There is little difference in general appearance between a tube formed of fish-debris and one of fir-leaves, but no examples contain a mixture of the two. A tube may, as Davies observed, include scales of more than one species of fish, but it includes nothing except fish-debris. Another tube consists of leaves, bits of bark, and so forth, but comprises nothing that is not vegetable. So, again, specimen A 1583 contains ossicles of both



CRETACEOUS TEREBELLOID WORM-TUBES.

Ophiurids and Asteroids, but there is nothing that is not echinodermal. One could wish for rather more definite evidence as to the precise locality and horizon of all our specimens, but it is at any rate well known that the tubes of fish-debris occur throughout the Upper Cretaceous rocks of South-East England, and one fails to see why the animals that made them should not occasionally have mixed their materials, as do their modern analogues. Here, however, we must observe that fish-scales do not appear to be in common use among modern tube-builders.

The particular materials used in each case appear to depend not merely on propinquity, but also on the ease with which the particular species can use them. The relative weight of the materials, the nature of their surface, or the differences of size may each or all affect their adaptability to the creature's mechanical powers. Whatever be the reason, certain species do, as we have seen, exercise a power of selection, and to that extent the converse holds good, namely, that tubes composed of obviously selected materials characterize diverse species.

All these considerations incline me to the conclusion that the remains of fishes, plants, and echinoderms were selected by three different species of worm. But before distinguishing these species by name, I await such confirmatory evidence as would be afforded by the occurrence of these three kinds of tube at the same level in a single limited area. Some of our enthusiastic students of the Chalk will doubtless be able to furnish the national collection with the desired material.

(*To be concluded in our next Number.*)

EXPLANATION OF PLATE XXIV.

FIG. 1. *Keckia* (?) sp. Probably Lower Cenomanian, South-East England. B.M. 4784.

.. 2. *Granularia* (?) sp. Albian, Gault, Folkestone. Portion of a small slab covered with similar tubes. B.M. 39453. × 2 diam.

.. 3. '*Terebella*' *cancellata*, n.sp. Cenomanian, probably *Holaster subglobosus* zone, Glynde, Sussex. Holotype. B.M. 58253.

.. 4. '*Terebella*' *cancellata*, n.sp. Probably same horizon, Cowslip Pit, near Guildford, Surrey. Portion of the infilling of a tube. The photograph shows the impressions, but does not bring out their curved arrangement; this has therefore been emphasized by a little white paint along one curve. The diagonal striation is very clear in the photograph, but is too fine to be reproduced by the half-tone process; one line has been emphasized, to show the direction. B.M. A 1577.

.. 5. '*Terebella*' *cancellata*, n.sp. Same horizon and locality. Portion of the infilling of a tube in which the longitudinal folds are strongly marked. B.M. A 1574.

.. 6. '*Terebella*' *intensis*, n.sp. Albian, Gault, Eastbourne. B.M. A 23. × $\frac{1}{2}$.

.. 7. '*Terebella*' *lewesiensis* (?). Cenomanian, Dorking Pit, Surrey. Tube made of conifer leaflets and bits of bark, imbricating. B.M. A 1566.

.. 8. '*Terebella*' *lewesiensis* (?). Cenomanian (?), South-East England. Part of a wide tube of long conifer leaflets, irregular, but mostly longitudinal. B.M. A 1568.

All figures are natural size, except Nos. 2 and 6. All are from photographs by Mr. H. G. Herring.

II.—On some Crustacea of the Division Syncarida from the English Coal-measures.

By W. T. Calman, D.Sc.

I. *Palæocaris præcursor* (H. Woodward).

Among the Crustacea from the Coal-measures of Coseley, near Dudley, which have been lent to me for examination by Mr. Walter Egginton, are a number of specimens of a form probably identical with that described by Dr. Henry Woodward[1] as *Præanaspides præcursor*. These specimens make it possible to supplement, in some important particulars, the original account of the species, and throw fresh light on its relations to the living Syncarida. Reasons are given below for regarding the genus *Præanaspides* as a synonym of *Palæocaris*, Meek & Worthen.

Description of the Material.—The fossils are contained in nodules of clay-ironstone, and in most cases the parts of the animal are represented by cavities in the matrix, exposing the inner surface of the exoskeleton when the nodule is split open. The cavities are usually lined with a brownish film, probably representing the substance of the exoskeleton,

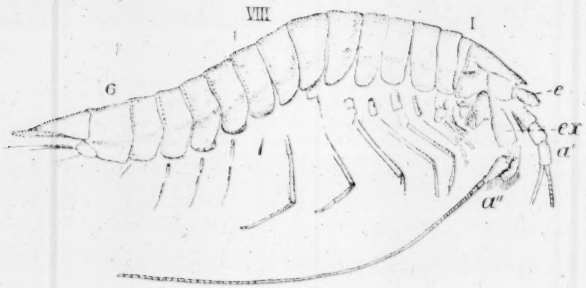


Fig. 1. *Palæocaris præcursor* (H. Woodw.). Specimen No. 8 in Mr. Egginton's collection. × 4½. *a'*. antennule; *a''*. antenna; *e*. eye-stalk; *ex*. part of exopodite or scale of antenna; I, first thoracic somite; VIII, eighth thoracic somite; 1, first abdominal somite; 6, sixth abdominal somite.

and are more or less filled in places by deposits of pyrites and of a soft white substance, probably ferrous carbonate. The cavity of the abdomen in some specimens contains an elongated cylindrical body which may perhaps represent the fossilized contents of a capacious intestine.[2]

[1] Geol. Mag., Dec. V, Vol. V, p. 385, 1908.

[2] It may be useful to give some notes on the methods that have proved most effective in the study of these fossils. A Zeiss binocular dissecting microscope was used, and the cleaning of the specimens with needles was aided by cautious applications of hydrochloric acid. The interpretation of the hollow parts is greatly facilitated by taking impressions in modelling wax, but it has to be borne in mind that these impressions of the *inner* surface of the exoskeleton do not give accurately the relief of the *outer* surface, for example, in the relation of the mandible to the side-plate of the head, as shown in Fig. 2, A. In some cases the parts of the fossil (e.g. the thoracic exopodites) are distinguished from the matrix by a difference of colour, not of relief. These are seen most clearly if the surface be wetted and a thin cover-glass placed on it.

In the most complete specimen (Fig. 1) the body, of which the side view is exposed, is about 16 mm. in length, and is curved so that the dorsal edge is convex in the thorax and concave in the abdomen. Eight thoracic somites are visible behind the head, followed by six abdominal somites and the telson.

The *head* (Fig. 2, A) is about 1·8 mm. in length and the same in depth at the hinder edge. It is produced in front into a very short rostrum, beneath which the margin shows a distinct concavity no doubt representing the orbital notch. The lower margin appears to overlap the bases of the mouth-parts as a pleural fold, although this cannot be clearly seen on the internal aspect as exposed in the fossils. On the side of the head a very distinct groove (represented by a ridge on the inner surface) runs vertically upwards from the basal angle of the mandible, but dies out before reaching the dorsal surface. A horizontal groove, starting from the hind margin at about the middle of its height, runs forwards for a short distance, but does not reach the vertical groove. In the specimen represented in Fig. 1

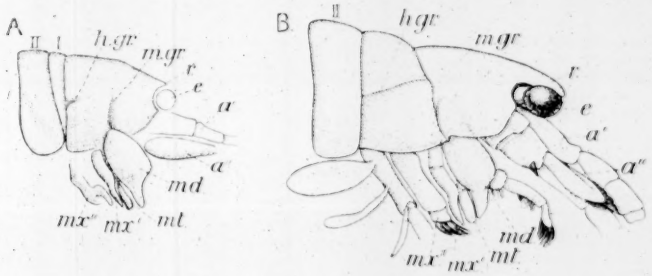


FIG. 2. Lateral aspect of head-region. A. *Palæocaris præcursor*. Drawn from a wax impression of specimen No. 15 in Mr. Egginton's collection; the side-plate of the head would overlap the base of the mandible if the actual outer surface were seen. × 5. B. *Anaspides tasmaniæ*. × 6. *a'*. antennule; *a''*. antenna; *e*. eye; *h.gr*. horizontal groove; *md*. mandible; *m.gr*. mandibular groove; *mt*. metastoma; *mx'*. maxillula; *mx''*. maxilla; *r*. rostrum; I, first thoracic somite; II, second thoracic somite.

this horizontal groove is obscured by a strong fold that runs for the whole length of the head, but this is evidently due to crumpling of the exoskeleton. The vertical and horizontal grooves seen in Fig. 2, A, however, are certainly normal features and are seen in several of the specimens; their significance will be discussed below.

The *first thoracic somite* is very short, its dorsal margin being only about half as long as that of the succeeding somite. In side view it is wedge-shaped, narrowing below so that the fore edge of the second somite almost touches the head at its lower end. It is possible that the line defining the first somite from the head may indicate a suture rather than a movable articulation, for no overlapping of the edges can be observed.

The remaining thoracic somites differ in length among themselves, but owing to the varying degrees of flexion or extension of the body in the different specimens it is not easy to determine the exact

relations in this respect. The fifth somite appears to be the shortest, and at all events the side-plates of this somite are distinctly narrower (antero-posteriorly) than those of the adjacent somites. The seventh somite appears to be the longest. On the dorsal side the second, third, fourth, and fifth somites are seen each to overlap the somite in front, while the sixth, seventh, and eighth, like those of the abdomen, overlap backwards. It is probable that the fifth somite overlaps both in front and behind, but this cannot be distinctly seen.[1] In one other respect also the fifth somite divides the thorax into two regions, for the second, third, and fourth somites have the lower margin of the side-plates rounded with a slight obliquity forwards, while those of the sixth, seventh, and eighth are pointed and directed backwards. The lower margins do not seem to overhang the bases of the legs. The depth of the thoracic somites is about 2 mm.

The *abdomen*, excluding the telson, is a little shorter than the thorax. The first five somites do not differ greatly in size, the length of each being a little less than that of the posterior thoracic somites. The pleural plates are rounded and slightly produced backwards. The sixth somite is a little more than half as long again as the fifth and of equal depth anteriorly, narrowing a little posteriorly.

The *telson* is not well displayed in any of the specimens. It is shorter than the uropods, broadly rounded at the tip, and fringed with spines. Its great apparent thickness at the base in side view may be due to crushing.

Appendages.—In several of the fossils a very distinct impression is seen in front of the head above the base of the antennule. There can be little doubt that this represents the *eye-stalk*; although the form of its distal end is not clearly defined in any of the specimens. It tapers slightly towards the base and appears to have been at least twice as long as its greatest diameter.

The *antennule* has the three segments of the peduncle successively diminishing in thickness; the first is the longest and the second the shortest. The flagella are incomplete in the specimen figured, but another specimen shows both of them to be at least twice as long as the peduncle.

The *antenna* shows distinct traces of a large lamellar exopodite, but in no case can its complete outline be traced. The last segment of the peduncle appears to bear a prominent lobe fringed with setæ, but it is possible that this is really the tip of the overlying exopodite. The flagellum is about as long as the body; its segmentation is very distinct in some specimens, the segments being broader than long and slightly oblique near the proximal end and becoming longer than broad towards the tip.

Impressions of the *mandibles* (Fig. 2, A) can be seen in many of the fossils. The 'body' of the mandible is large and its obtusely pointed proximal end is overlapped by the side-plate of the head; distally it is produced into a narrow incisor process, and it forms on the anterior margin a marked shoulder where the palp may have been articulated.

[1] In *Anaspides* the fourth thoracic (third free) somite overlaps both in front and behind. I have not been able to determine the overlap of the somites in the other recent genera.

Traces of other mouth-parts are seen in some of the specimens, and in one (Fig. 2, A) they resemble so closely the mouth-parts of *Anaspides* (Fig. 2, B) as seen from the side that there can be little hesitation in identifying the *metastoma* (lower lip), *maxillula*, and *maxilla*.

The eight pairs of *thoracic limbs* all appear to be slender in the specimens examined. Those of the first pair are only obscurely seen and appear to be very short; the others successively increase in length. The apparent slenderness of these limbs in comparison with those of the type-specimens of *P. præcursor* will be discussed later.

Several specimens show traces of *exopodites* on the thoracic limbs, and they are very clearly seen in the specimen figured (Fig. 3). They are flattened and lanceolate in outline, about 1·5 mm. in length, and ·2 mm. across the widest part. Each is divided into a number of short segments, which are broader than long except towards the tip. No traces of marginal setæ are preserved. No exopodite can be seen on the last thoracic leg, and it is probable that this limb was devoid of an exopodite as it is in the living Anaspidacea.

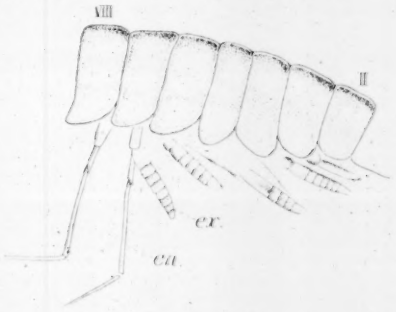


FIG. 3. *Palæocaris præcursor*. Portion of thoracic region showing legs and exopodites. From specimen No. 19 in Mr. Egginton's collection. × 6. *en.* endopodite; *ex.* exopodite; II, second thoracic somite; VIII, eighth thoracic somite.

The remains of the *pleopods* are somewhat obscure. The *uropods* are not well displayed in any of the fossils, but, as far as can be seen, they agree with the original description of *P. præcursor*.

Comparison with Præanaspides præcursor.—The specimens described above agree closely with the original account of *P. præcursor* in the form and segmentation of the body, and in the general structure of the appendages as far as these are available for comparison. They differ in their generally smaller size, the absence or obscurity of the transverse striation of the somites, the wedge-like outline of the first thoracic somite as seen from the side, and the greater slenderness of the thoracic limbs. As regards the first of these points, none of the specimens now examined can have much exceeded 16 mm. in length, while one of the co-types of the species reached a length of 57 mm. Dr. Woodward, however, mentions specimens of 15 mm. and even 10 mm. in length. The absence of striation on the somites may not improbably be due to a difference in the condition of preservation.

The first thoracic somite is described and figured by Dr. Woodward as parallel-sided in lateral view, but a slight depression of the head might probably produce the wedge-like outline seen in the specimens figured above, the first somite being overlapped by the side-plates of the second somite.

The difference in the form of the legs is much more likely to be significant. In one of the co-types of the species, that represented in Fig. 3 on p. 386 of Dr. Woodward's paper, and now in the British Museum collection, the endopodite of the penultimate leg is well displayed, and the large segment on the proximal side of the 'knee' (probably the merus) is less than four times as long as broad. In a specimen in Mr. Egginton's collection, represented in Fig. 3 above, the corresponding segment of the penultimate leg appears as if it were at least ten times as long as broad. A careful examination of both specimens, however, does not convince me that they are exactly comparable in this respect. The apparent broadening of the limb in the one case may be somewhat exaggerated by compression, while, on the other hand, a flattened segment might not display its full width if it happened not to lie exactly in the plane of fracture of the matrix. I think, therefore, that the evidence is inadequate to justify the separation of the Coseley specimens as a distinct species from that described by Dr. Woodward.

Comparison with Palæocaris.—The genus *Palæocaris* was established by Meek & Worthen in 1865[1] for a single species, *P. typus*, of which a figure was published by the same authors in 1868.[2] The species was discussed at greater length and a restoration given by Packard in 1886.[3] Other species have since been referred to the genus, but they are too imperfectly known to require further consideration here.[4]

The restoration of *Palæocaris typus* given by Packard and reproduced here (Fig. 4) agrees very closely with the original figures of *Præanaspides* as regards the segmentation of the body. It differs chiefly in the form of the thoracic legs, of which six pairs are shown, having the endopodites very slender and the exopodites broad, flattened, and each divided into three segments. For the reasons given above I cannot regard the apparent slenderness of the endopodites as important, and it may be significant that in Meek & Worthen's original figure the legs are represented as much stouter than in Packard's restoration. In this character and in the form of the exopodites the Coseley specimens described above agree remarkably well with Packard's figures, the only important divergence being that the segments of the exopodites are more numerous. This, however, is a point on which it is very easy to be misled, and it is not unlikely that Packard may have overlooked some of the delicate lines of articulation. The greater

[1] Proc. Acad. Nat. Sci. Philadelphia, 1865, p. 48.

[2] Geol. Surv. Illinois, iii, p. 552.

[3] Mem. Nat. Acad. Sci. Washington, iii (2); Mem. 15, pp. 129–33, pl. iii.

[4] It is possible that *Palæocaris Burnettii*, H. Woodward (Geol. Mag., Dec. II, Vol. VIII, 1881, p. 533, Pl. XIV, Figs. 3*a*, *b*), might prove to be identical with the species discussed here, but the specimen from which it was described is probably too imperfect to make sure of this.

relative length of the sixth abdominal somite in the American specimens seems to be almost the only difference available for their specific separation from the English form, and it is possible that even this might not survive a re-examination of the fossils. At all events it seems clear that the two forms cannot be generically separated, and I propose to regard *Praeanaspides* as a synonym of *Palæocaris*.

Comparison with recent Syncarida.—A comparison of the head-region of *Palæocaris* as described above with that of the recent Syncarida (see Fig. 2) leads to some important conclusions. There is hardly room for doubt that the groove running upwards from the base of the mandible on the side of the head corresponds to the so-called 'cervical groove' of *Anaspides* (Fig. 2, B) and *Paranaspides*, and the fact that it dies out before reaching the dorsal surface is paralleled in *Koonunga*. The horizontal groove behind it has exactly the same relations as the similar groove found in *Anaspides* and *Paranaspides*, though it does not extend so far forward as in these genera.

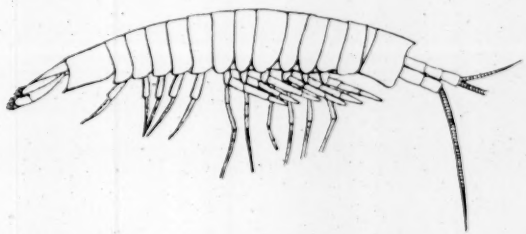


FIG. 4. *Palæocaris typus*. Restoration. After Packard.

I formerly suggested[1] that the 'cervical groove' of *Anaspides*, which had been regarded as defining the first thoracic somite from the head, should rather be identified with the 'cervical sulcus' which, in the Mysidacea, crosses the carapace immediately above the mandibles. Later[2] I expressed some doubt as to this interpretation, but it is very strongly supported by the evidence of the fossils now described. The narrow and generally wedge-shaped segment behind the head in *Palæocaris* must undoubtedly be regarded as the first thoracic somite, and there is nothing visible in the living Syncarida which can be compared with it. The term 'mandibular groove' may conveniently be applied in all these cases to the groove running upwards from the attachment of the mandible.

The confirmation now afforded of previous statements as to the existence of pedunculated eyes and of thoracic exopodites in the fossil Syncarida goes to strengthen the case for their association with the living Anaspidacea. Almost the only conspicuous structural feature of the latter that has not been recognized in the former is the series of lamellar gills on the thoracic legs. From the delicacy of their texture it is hardly likely that these would be preserved, but it is not beyond possibility that traces of them may yet be discovered.

[1] Trans. Roy. Soc. Edinb., xxxviii, p. 787, 1896.
[2] Ann. Mag. Nat. Hist. (7), xiii, p. 155, 1904.

II. Further Note on *Pleurocaris annulatus*.

Since the publication of my paper on this species[1] I have been able to examine a very successful impression taken from one of the British Museum paratypes (I. 13814) by Mr. T. H. Withers, and showing some features that were overlooked in the examination of the fossil itself. The most important of these relate to the upper surface of the head (Fig. 5), which was not displayed in any of the other specimens examined.

The anterior margin of the head is produced into a short, bluntly pointed rostrum. On each side of this is an impression that most probably represents the basal segment of the antennule, although it is not impossible that it may be an eye-stalk. The head-region is divided by a strongly-marked transverse groove into two portions, of which the posterior is wider than the anterior, and more than half its length measured to the tip of the rostrum. On each side of the posterior division is a swollen area marked off by a groove, which has an oblique and sinuous course from the antero-lateral corner to the posterior margin, which it reaches at a little distance from the middle line.

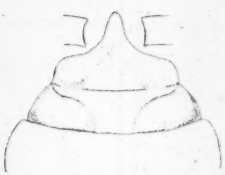


Fig. 5. *Pleurocaris annulatus*. Restoration of dorsal surface of head-region, based on an impression taken from one of the paratypes (I. 13814) in the British Museum collection.

Behind the head-region just described this specimen shows very clearly that there are only *seven* free thoracic somites, all of them provided with expanded pleural plates. It is therefore possible that the posterior division of the head-region, marked off by the transverse groove, may represent the first thoracic somite. On the other hand, the groove seems to lie just about the region of the mandibles, and well in front of the position where the anterior limit of the first thoracic somite might be expected. It seems much more probable, therefore, that it is to be identified with the 'mandibular groove' described above in *Palæocaris*. If this be so the groove defining the swollen area on each side may very well represent the 'horizontal groove' of *Palæocaris* and *Anaspides*.

Apart from the morphological interpretation of the parts, however, the dorsal aspect of the head-region presents a very close similarity to that described and figured by Packard in *Acanthotelson*.[2] In both cases the head region is divided by a transverse groove into two parts, of which the posterior is the longer and the anterior is provided with a short rostrum; in both cases also the posterior division has on each

[1] Geol. Mag., Dec. V, Vol. VIII, p. 156, 1911.

[2] Mem. Nat. Acad. Sci. Washington, iii (2); Mem. 15, p. 124, pl. i, fig. 1*a*, 1886.

side 'a low boss-like swelling situated obliquely'. The agreement is sufficiently close to put beyond doubt the affinity, already suggested, between *Pleurocaris* and *Acanthotelson*.

I am indebted to Dr. Henry Woodward for calling my attention to an additional specimen of *Pleurocaris* in the British Museum collection (I 14449) from the same locality as the type-specimens. It differs from these, not only in its larger size (the total length when complete cannot have been much less than 30 mm.), but also in being relatively much wider, measuring 10 mm. across the widest part. This increase in width is due to the greater size of the thoracic pleural plates, which extend on each side for a distance nearly equal, in the middle of the thorax, to the transverse diameter of the somites themselves. It is probable that the increased size of the pleural plates is merely a character of maturity or of age, and that it does not indicate a distinct species.

III.—The Culm-measures of the Exeter District.

By E. A. Newell Arber, M.A., F.G.S., Trinity College, Cambridge.

IN the interesting paper, by Mr. F. G. Collins, on the so-called Culm-measures of the Exeter district, which has recently appeared in the last number of the Quarterly Journal,[1] there are to be found certain conclusions which can hardly pass unchallenged. When this paper was read at the Geological Society, I happened to be in the extreme west of Ireland, and thus, unfortunately, I was unable to be present at that meeting or to take part in the discussion. In fact, it was not until my return to Cambridge in September that I knew anything of the substance of the paper, beyond the very small contribution on the fossil plants which I wrote for it some time ago.

The chief value of this paper lies in the records of the Carboniferous fauna from South Devon. I must, however, take exception to the author's chief conclusions.[2] Mr. Collins remarks that "comparing the list of South Devon forms with that of the fauna of the 'Pendleside Series' and that of the Carboniferous Limestone as tabulated above, we cannot fail to be impressed with the great resemblance of this fauna to that of the 'Pendleside Series'". Also that "the fossils, however, described in the present note, support for South Devon what Dr. Hind has stated to be the case in North Devon, namely, that the Lower Culm-measures are the homotaxial equivalents of the 'Pendleside Series' of the Midlands". Whether or not the scanty flora mentioned in the paper is intended to be included in these conclusions is not self-evident, but I wish to take the opportunity of pointing out that the rocks from which the few fragmentary plant remains there recorded were obtained, are beyond question of Upper Carboniferous age.

It is quite clear that, both as regards the plants and the fauna, Mr. Collins has failed to recognize the important fact that rocks belonging to both the Upper and Lower Carboniferous series occur

[1] Quart. Journ. Geol. Soc., vol. lxvii, pt. iii, p. 393, 1911.
[2] Ibid., pp. 411, 413.

in the neighbourhood of Exeter. He treats the whole flora and fauna as if it belonged to one division of the stratigraphical series, whereas the specimens from some localities are of Lower, and those from others of Upper Carboniferous age. I imagine that if the author had collected fossils around May Hill, in Gloucestershire, where there is a series of sediments ranging from the Silurian to the Jurassic and including the Carboniferous, he would have paid some attention to the stratigraphy of the area, and would not have treated the whole of his collection as if it belonged to one formation or a particular subdivision of a single formation, as he has done in this case.

In this connexion it may be well to point out once again that before 1840 Sedgwick & Murchison[1] had realized that both the Lower and Upper Carboniferous formations are represented in the Devonshire syncline. The rocks belonging to the Lower series they called the Lower Culm-measures, those to the Upper, the Upper Culm-measures. I have also adopted this twofold division in my papers on the Culm-measures of North and West Devon,[2] though, as I then pointed out, the term Culm-measures is misleading and unnecessary, and is therefore best dropped.[3]

The Lower Carboniferous rocks (Lower Culm-measures) of Devonshire are quite distinct lithologically from those belonging to the Upper Carboniferous, and where a clear section exists there should be little possibility of mistaking the one for the other. I am not acquainted with the Culm-measures near Exeter in the south-east corner of the basin in detail, but in the south-west corner in North Cornwall I have studied them carefully, and they will be found described in my *Coast Scenery of North Devon*, recently published. There the lithological differences between the Upper and Lower Culm-measures are certainly marked. But I may point out that it has been known for many years past that both Lower and Upper Culm-measures occur around Exeter. Lower Culm-measures are indicated to the west and south-west of Exeter on the sketch-map accompanying Messrs. Hinde & Fox's well-known paper on the Radiolarian rocks of Devon.[4] The relations of the Lower to the Upper Culm-measures in this district are also shown very clearly in the admirable map accompanying Mr. Ussher's paper[5] on the Culm-measure types of Great Britain, published in 1901. It is true that in the revised Survey map (Sheets 325 and 339) of the Exeter district the two series are not distinguished from one another, but in the accompanying memoir Mr. Ussher[6] has clearly discriminated between them.

[1] Sedgwick & Murchison, Trans. Geol. Soc., ser. II, vol. v, pp. 682, 684, 1840.

[2] Arber, Phil. Trans. Roy. Soc. London, ser. B, vol. cxcvii, p. 291, 1904.

[3] The term 'Culm', as used by Mr. Collins in the title of his paper, is even more objectionable. It is an old West of England word for the slack of an anthracitic coal. As used by geologists, it is apparently a translation of the German 'Kulm', which itself originated on the Continent under a misconception of the nature of the Culm-measures of Sedgwick & Murchison in Devon and Cornwall.

[4] Hinde & Fox, Quart. Journ. Geol. Soc., vol. li, p. 609, pl. xxiii, 1895.

[5] Ussher, Trans. Inst. Min. Engineers, vol. xx, p. 360, pl. xvi, 1901.

[6] Ussher, *The Geology of the Country around Exeter* (Mem. Geol. Surv.), ch. ii, 1902.

Some of the localities from which Mr. Collins has obtained fossils, especially those of Canonteign, Popehouse Close, and Doddiscombsleigh, are situated on the well-known patch of Lower Carboniferous rocks, stretching from the north-east corner of Dartmoor to and beyond the valley of the Teign. Others, including all those from which plants were obtained, consist of rocks of Upper Culm-measure, i.e. Upper Carboniferous age.

With regard to the Lower Carboniferous rocks and their fauna, whether in North or South Devon, I have no remarks to make. These beds may be the equivalents of the Pendleside Series, as Dr. Hind has urged. On this conclusion I offer no comment. I have not paid particular attention to the fauna of these rocks, and I make no claim to the special knowledge of Carboniferous invertebrates necessary to enable one to enter into this discussion.

In regard, however, to the rocks at Clyst Hydon, Westwood Church, Pinhoe, and Perridge, which have yielded plant-remains, there can be no hesitation in believing them to be of Upper Carboniferous age, and they have been mapped as such by Mr. Ussher. They are what I regard as Upper Culm-measures, but which Mr. Ussher has mapped as Middle Culm-measures.[1] To which division of the Coal-measures they should be assigned remains uncertain, for the flora is too fragmentary to permit of any conclusion as to the horizon. With regard to the localities from which some of the mollusca, other than the Lower Carboniferous species already discussed, have been obtained, I strongly suspect that they also are of Upper Carboniferous age, but here again I must leave it to those who are more competent than I am in such matters to confirm or refute Mr. Collins' conclusions on this point. I wish, however, particularly to emphasize the view that, while Mr. Collins' conclusion that the rocks from which mollusca have been obtained around Exeter are the equivalents of the Pendleside Series of the Midlands may hold in so far as some at least of the localities are concerned, it certainly does not hold in regard to those which have yielded Upper Carboniferous floras, scanty though they be, in areas which no one has hitherto suspected of being other than of Coal-measure age.

IV.—On some Arthropod Remains from the Nottinghamshire and Derbyshire Coal-field.[2]

By Lewis Moysey, B.A., M.B., F.G.S.

As several rare and interesting fossils from this coal-field have been described in this Magazine[3] and elsewhere,[4] it seems advisable to place on record several other animal remains from the same district

[1] I have, for reasons stated in my previous papers on Devonshire, adopted the twofold classification of the Culm-measures initiated by Sedgwick & Murchison, in preference to the threefold scheme of Mr. Ussher, whose 'Middle' and 'Upper' are included in my Upper Culm-measures.

[2] Read in part before Section C, British Association, Sheffield Meeting, 1910.

[3] H. Woodward, *Eurypterus Moyseyi*, Geol. Mag., Dec. V, Vol. IV, pp. 277–82, Pl. XIII, 1907; also *Praeanaspides praecursor*, Geol. Mag., Dec. V, Vol. V, pp. 385–96, text-figure, 1908.

[4] R. I. Pocock, Monograph Carboniferous Arachnida: Proc. Palæont. Soc., vol. lxiv, pp. 1–84, pl. iii, 1911.

which, owing to their minuteness, or to the fact that they are fragmentary, are not worthy of a separate and detailed description, in the hope that their publication may inspire geologists to obtain better and more perfect examples from other localities.

The sources from which the following specimens were obtained are:—Horizon, Top Hard Coal: Shipley Clay-pit, Derbyshire; Brinsley Clay-pit, near Eastwood, Nottinghamshire; Digby Clay-pit, Kimberley, Notts. Horizon between Waterloo and Ell Coals: Newthorpe Clay-pit, Eastwood, Notts. Horizon, roof of Kilburn Coal: Trowell Colliery refuse heap, Notts.

Fig. 1, *Leaia trigonioides*, sp. nov. Several of these minute bodies, about 3 mm. long, were discovered scattered throughout the substance of an ironstone nodule from Shipley. They were for the most part fragmentary, but two, one perfect and the other almost perfect but crushed, have been selected for description. They represent the right and left valves of what may be taken to be the carapace of a Phyllopod.

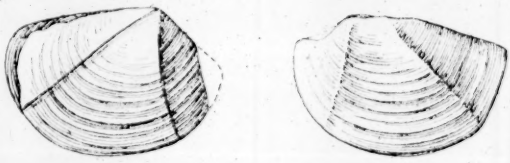


FIG. 1. *Leaia trigonioides*, sp. nov. Right and left valves of carapace. Coal-measures: Shipley, near Ilkeston, Derbyshire. Nine times nat. size.

The umbo is tumid, and is situated at the junction of the anterior and middle third of the total length of the carapace. The hinge-line or dorsal border is straight and terminates at the umbo. The anterior border runs downwards and forwards, making a rounded angle where it meets the semicircular ventral border, which latter extends posteriorly to meet the dorsal border in a more or less sharp angle. The surface of the carapace is ornamented by two well-marked curved ridges, radiating from the umbo; one downwards and forwards, the other downwards and backwards. These ridges die out before reaching the margin of the valve, thus leaving a smooth flattened ventral border. The surface is also ornamented with about nine concentric riblets, with smooth bands between, which are best seen in the median area of the valve.

A somewhat similar fossil was described by Lea[1] from Pennsylvania under the name of *Cypricardia leidyi*. Professor T. Rupert Jones,[2] in his monograph on the Phyllopods, gave it the name of *Leaia leidyi*, and described two varieties, one *Leaia leidyi*, var. *williamsoniana*, from Ardwick near Manchester, and the other *Leaia leidyi*, var. *salteriana*, from Cottage Row, Crail, Fifeshire. The present example agrees fairly closely with the Fifeshire specimen; but, on the whole, it seems best to create a new species for it, *Leaia trigonioides*, rather than risk confusion by adding a varietal appellation.

Fig. 2, *Prestwichia* sp. This is mainly of interest owing to the great difficulty of its interpretation, and was found at Shipley. It

[1] Proc. Acad. Nat. Sci. Philadelphia, vol. vii, p. 341, pl. iv, 1855.
[2] Mon. Palæont. Soc., Appendix, p. 115, pl. i, figs. 21*a*, *c*, 1862.

is bilaterally symmetrical, and consists of two broad alæ, which are divided up into irregular, more or less concentric areas, by three ill-defined radiating ridges. They are separated from one another by a well-marked median ridge which at one end divides into a deep V. A broad transverse ridge divides the expanded alæ from the other portion of the fossil, which consists of two concave elongated areas, which terminate in a couple of short blunt spines. There are also to be seen on each side the median ridge a pair of semi-lunar dots with their concavity directed towards the median line.

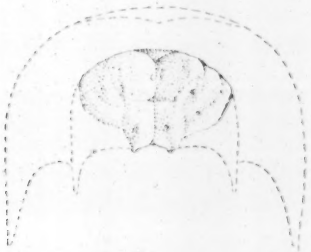


FIG. 2. ?Glabellar region of *Prestwichia*. Coal-measures: Shipley, near Ilkeston, Derbyshire. Nat. size.

This puzzling specimen is capable of various interpretations; possibly the best is that it is the glabellar region of a *Prestwichia*. The presence of the pair of dots, one on each side the median line, is in favour of this theory, on the assumption that they are the larval eyes of the animal.

FIG. 3. Terminal segments of air-breathing Arthropod. Kilburn Coal: Trowell Colliery, Notts. Twice nat. size.

Fig. 3, Air-breathing Arthropod, indet. A small fragmentary fossil found in a nodule from the roof shale of the Kilburn Coal, Trowell Colliery, is also very puzzling. It shows what appears to be the terminal moiety of a segmented animal, with thick and possibly calcareous integument.

The ultimate segment is perfect, and consists of a shield-shaped plate about 1½ times as broad as long; convex from side to side and

also from before backwards. Its postero-lateral border is deeply emarginate, and its posterior border is prolonged backwards in the median line. The penultimate segment is fairly perfect, about three times as broad as long.

The ante-penultimate segment overrides the penultimate owing to the crushing of the fossil, and is very imperfect, its anterior border being chipped off. It appears, however, to have been similar to the penultimate segment.

The succeeding segment is very crushed, and overrides the last described, and is so intimately confused with the fragments of succeeding segments that it is impossible to make much out of it.

On the ultimate segment, in the median line, and half-way between the anterior and posterior border, occurs a minute circular pore, which may doubtfully be referred to the anal orifice, but is so minute that it could well be the opening of an odoriferous gland, similar to those found on the side of the body of modern Myriapods. The chief point of interest, however, in this specimen, is a double row of transversely placed, crescentic openings, somewhat raised from the general surface, and with tumid margins, which occur on each segment. One row is placed far out towards the lateral margin and the other on each side the median line. These openings are so similar in appearance to the respiratory stigmata found in scorpions and other Arachnids, that we may safely conclude that they had a similar function.

If correctly interpreted, the presence of stigmata and the doubtful anal orifice make it certain that we are here dealing with the posterior ventral plates of an air-breathing Arthropod, although their curvature and appearance of overlapping give the impression that they are the dorsal plates. The presence, however, of two pairs of stigmata on each segment is peculiar, and it is difficult to correlate this specimen with any living or fossil form.

FIG. 4. Post-abdominal segment of Scorpion. Coal-measures: Shipley, near Ilkeston, Derbyshire. One and a half nat. size.

Fig. 4, Segment of body of a Scorpion. This is probably one of the post-abdominal segments of one of the scorpions, and is of interest mainly because the remains of scorpions are extremely rare. Two other examples, more perfect than this, have been obtained from this coal-field, one described by Dr. H. Woodward,[1] from the neighbourhood of Chesterfield, and another found by myself from the Digby Clay-pit, Kimberley, Nottinghamshire, and described as *Eobuthus holti* by Mr. R. I. Pocock.[2] The present example occurs in a rounded ironstone nodule. Its anterior part consists

[1] H. Woodward, GEOL. MAG., 1875, p. 622.
[2] R. I. Pocock, loc. cit. supra.

of a projecting swollen ring, with a slight depression on its most prominent part, evidently forming a facet for articulation with the next anterior segment. Behind this ring is a deep sulcus separating the anterior from the posterior portion of the fossil. The latter portion is quadrate, slightly broader than long, somewhat convex from side to side, and gradually narrowing posteriorly. Its posterior border is straight. It shows a distinct median ridge, extending only half the length of the segment, and two lateral ridges which extend fully to the posterior border. Anteriorly the lateral ridges are connected with the median one by transverse ridges, which form the posterior boundary of the above-mentioned sulcus. The specimen measures 10·5 mm. long by 9 mm. broad. It is in all probability the first segment of the post-abdomen, the articulatory facet being the point of attachment with the last segment of the præabdomen.

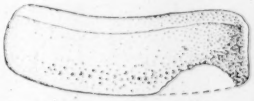


FIG. 5. Abdominal segment of *Eurypterus*. Coal-measures: Brinsley, near Eastwood, Notts. Twice nat. size.

Fig. 5, Segment of a *Eurypterus*. This detached segment of an Arthropod was found at Brinsley Clay-pits, in a small ovoid ironstone nodule. It measures 17·5 mm. broad by 6 mm. long. Its anterior border is slightly concave, and there is a line running parallel with the anterior border, and curving round to run also parallel with the lateral border, which marks off a space about 1·5 mm. wide, which is smooth. The rest of the surface of the segment is slightly roughened, but posteriorly, and laterally the roughening is exaggerated into well-marked, irregularly distributed tuberosities.

It is impossible from a single segment to allocate this Arthropod to its proper genus; but, provisionally, we may place it among the Eurypterids. It has not, it is true, the scale-like ornamentation usual to *Eurypterus*, but in the narrow abdominal segments of *E. moyseyi* the scale-like ornament is found to degenerate into tuberosities, and from its size the segment under discussion is probably one of these posterior segments.

FIG. 6. Carapace of *Anthracosiro*. Coal-measures: Shipley, near Ilkeston, Derbyshire. Three times nat. size.

Fig. 6, Head of an *Anthracosiro*. It is apparently very unusual, at any rate in England, to obtain a specimen of the *Anthracomarti* which shows either the head or the appendages in a perfect condition. One specimen, however, from Shipley shows the dorsal aspect of

a carapace which is not only perfect but uncrushed. Unfortunately it is quite detached and isolated, hence it is impossible with any scientific accuracy to ascribe it to any definite genus. Luckily, however, another carapace was discovered in another ironstone nodule, somewhat weathered and broken, but still capable of being compared with the perfect example, with which it was found to agree so closely that there can be little doubt as to their identity. Later, by careful development, it was found that the weathered carapace or prosoma was still attached to the opisthosoma of an Arachnid which can in all probability be referred to *Anthracosiro*.

The undamaged carapace is markedly dome-shaped, curving gradually anteriorly, while it falls rapidly posteriorly, leaving a flat central area between the domed portion and the straight posterior border. The anterior border is marked by two lateral rounded indentations, with slight-pointed prominences between, and an equally small central prominence or rostrum; the sides are rounded.

There is a faint median ridge running over the anterior half of the carapace, converted in the posterior half into a well-marked more or less stellate depression, with well-rounded lips, and occupying mainly the sharp downward posterior curve of the dome so that the depression looks upwards and backwards.

There is distinct evidence of a pair of protruding eyes, one on each side of the faintly marked median ridge, about 2·5 mm. apart, and placed on a transverse ridge running just in front of the stellate depression.

There are also to be noted several folds starting from the posterior part of the stellate depression and running round towards the sides. These, however, may be due to crushing. The whole surface is ornamented with very minute tubercles which are more pronounced in the posterior portion.

Dimensions: antero-posteriorly 6 mm., transversely 6·75 mm.

Another isolated and uncompressed carapace has been obtained from the same quarry, which appears to be identical, but is much smaller.

Dimensions: antero-posteriorly 4 mm., transversely about 4 mm., one side being embedded in matrix.

Figs. 7, 8, *Anthracosiro fritschii*, Pocock. The weathered carapace shows well the posterior flat area, the stellate depression and an eye on the left side, the rest of the anterior portion of the carapace being destroyed. Some of the appendages are also present. The limb emerging from beneath the carapace on the right side is probably one of the fourth pair of appendages, that is of the second legs. It consists of a short, distally dilated trochanter about ·75 mm. long, articulating distally with the long stout femur about 3·25 mm. in length, which runs directly out from the long axis of the body; running forward and at right angles to this is placed the patella, 2·5 mm. long; the next segment, the tibia, about equal in length with the patella, lies curving inwards towards the head. The next segment, the tarsus, lies in line with the last, is about the same length, but is somewhat obscured. The distal segment, the pretarsus, is not well shown. Embraced by the limb are the remains of four other appendages not shown in the Figure. The maxillæ on both sides, the

chelicera and first leg on the right side all emerge from under the weathered anterior portion of the carapace.

The body or opisthosoma is well shown, consisting of eight segments. The junction between the carapace and the first segment, the first and the second, and the second and third, are straight and show well-marked ridges; the succeeding ones are not so well marked, and curve with their concavity backwards more and more sharply until the eighth segment is in the form of a horseshoe, enclosing on three sides a more or less quadrilateral plate, at the anterior part of which is placed a characteristically large anal ring in which can be detected the anal orifice.

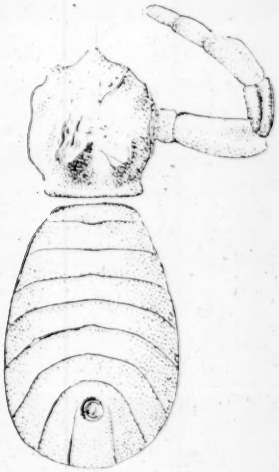


FIG. 7. *Anthracosiro fritschii*, Pocock. Showing carapace and opisthosoma, with appendage. Ventral aspect. Coal-measures: Shipley, near Ilkeston, Derbyshire. Three times nat. size.

FIG. 8. *Anthracosiro fritschii*, Pocock. Dorsal view of opisthosoma. Shipley, near Ilkeston, Derbyshire. Four times nat. size.

In this case we are dealing, as in the majority of specimens found at Shipley, with the ventral aspect of the body. In two specimens from this locality, however, we have preserved the dorsal aspect of the animal (Fig. 8 *supra*). One of these gives the flat posterior area of the carapace and a small portion of the left lateral region, also the remains of two ambulatory appendages represented by their femora on the right side. The opisthosoma consists of the usual eight segments, the first being the shortest; their posterior borders all run sub-parallel to one another, the lateral laminæ marked off from the tergites by a definite line being directed more and more backwards, until those of the eighth point directly backwards, and bound on either side the quadrilateral backward extending plate of the eighth tergite.

Fig. 9, *Anthracosiro fritschii*, Pocock (dorsal aspect). The other specimen is in an ironstone nodule mixed up with a confused mass of neuropterid pinnules and other plant debris. The carapace

is crushed and covers and obscures the coxæ of the appendages. On the left side the remains of four appendages are shown by their trochanters and femora: the most anterior of these is more slender than the others and possibly represents the second appendage, the posterior ones probably representing the fourth, fifth, and sixth appendages (second, third, and fourth legs). The opisthosoma is more perfect, but distorted by pressure. It shows the typical eight egments of the body. The lateral laminæ of the sixth and seventh segments alone can be made out, and there is apparently no diversional

FIG. 9. *Anthracosiro fritschii*, Pocock. Dorsal aspect. Shipley, near Ilkeston, Derbyshire. Three times nat. size.

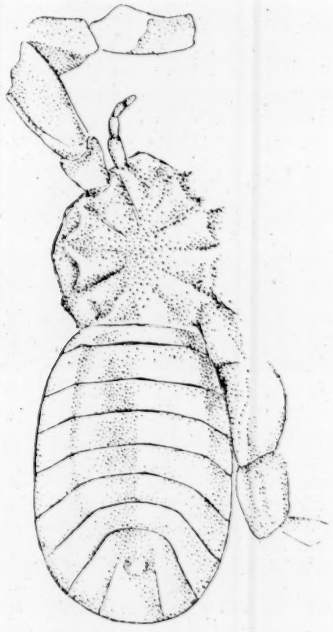


FIG. 10. *Anthracosiro woodwardi*, Pocock. Dorsal aspect, showing carapace and opisthosoma, with appendages. Shipley, Derbyshire.

line between these and their corresponding tergites. The eighth segment is very much crushed, but displays clearly through its substance the large ventrally placed circular anal orifice.

The above described specimens of *Anthracosiro*, though varying slightly in size, probably all belong to one species, and agree best with *A. fritschii*, Pocock. It would seem best, therefore, at any rate at present, to place them in that species.

Fig. 10, *Anthracosiro woodwardi*, Pocock. Another Shipley specimen is larger and more robust, and can with some certainty be referred to *Anthracosiro woodwardi*, Pocock. This specimen, though greatly obscured by a deposit of ferrous carbonate, shows a crushed carapace

which covers and obscures the radiating coxæ of the appendages which are just indicated beneath it. On the right side of the head are seen the fragments of a stout femur and patella of one of the ambulatory legs, probably the first, and on the left side, running parallel to the body, is another appendage, probably the fourth walking-leg. This leg extends backwards as far as the eighth segment of the body. The opisthosoma is perfect and gives the dorsal aspect of the animal. It consists of the normal eight segments. There is no evidence of the single pair of laterally placed tubercles on each terga, mentioned by Mr. Pocock, but these are probably obscured by the quantity of white deposit which is especially marked in that region.

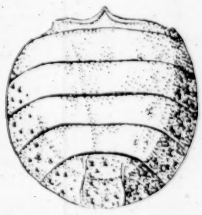


FIG. 11. Opisthosoma of an *Anthracomartus*. Dorsal view. Newthorpe, near Eastwood, Notts. Three times nat. size.

FIG. 12. Counterpart of Fig. 11, showing anterior somite.

Figs. 11, 12, *Anthracomartus*, indet. A beautiful little fossil obtained from the Newthorpe Clay-pit, Nottinghamshire, opened in the measures between the Waterloo and Ell Coals, presents the opisthosoma of an Arachnid. It shows the posterior six segments. The first segment visible on the fossil is very narrow, about one-quarter the length of the succeeding segments; its anterior border is prolonged medially into a sharp projection, hence the anterior border appears as if defined by a well-marked bracket-shaped line. This segment apparently has no lateral laminæ. The counterpart of this specimen is very imperfect (Fig. 12), but gives yet another anterior segment which is not traceable on the fossil. It consists of a very short V-shaped segment placed in an inverted position anterior to the bracket-shaped border of the other segment, and separated from it by about its own width of matrix.

The other segments are equal in length, each posterior border being parallel to the next. Owing to the fossil being uncompressed, each lateral lamina is bent over in a bold curve, thus giving to the specimen a transversely arched appearance, and they are at the same time directed slightly backwards. These laminæ are ornamented with irregularly placed, well-marked tubercles, larger towards the lateral margin. On the left side the lateral laminæ (and the ultimate segment) appear to have been removed, leaving the impression of their underside, so that the tubercles look like pits, and also demonstrating a divisional line between the terga and their respective laminæ. The rest of the segment is smooth. The ultimate segment consists of a more or less quadrate area, with its two lateral laminæ directed outwards and backwards, their posterior border being in contact with the posteriorly

projecting quadrilateral plate normal to this segment in most of the Anthracomarti.

The absence, or at least imperfection, of the anterior segments makes it extremely difficult to refer this Arachnid to its proper genus. It probably belongs to the order *Anthracomartus* of Pocock, and with some hesitation we may refer it to the genus *Trigonotarbus*. It is evidently, however, a new species, and it would be, at present, best not to name it definitely, but to leave it in the hope that some experienced arachnologist may in the future be able to give it a place in the now rapidly growing list of Carboniferous spiders.

In conclusion, it would be well to describe in some detail the locality from which so many of these and other rare or new fossils have been obtained, that it ranks with the Coseley Openworks near Dudley, and the Sparth Bottoms Brickfield, Rochdale, as one of the main sources of enrichment of our Coal-measure fauna. The spot in question is the Shipley Clay-pit, about 1½ miles north of Ilkeston, Derbyshire, situated on the Shipley Manor estate, and owned by E. H. Mundy, Esq., to whom, for his kindness in giving me opportunity to examine the nodules it contained, I am deeply indebted. The pit, which covers some two acres of ground, was opened in the yellow clays in the neighbourhood of the Top Hard Coal, probably some 30 to 40 feet below that seam. The clays abound in ironstone nodules, arranged in bands, every one of which, when broken, reveals the presence of some organism, either plant[1] or animal, in a perfect or fragmentary condition. It was found, however, that nodules which were more or less symmetrical, either round or ovoid, usually contained the most perfect specimens. To such an extent was this the case that, latterly, symmetrical nodules were collected and brought home to be broken at leisure by freezing or by other means, with most satisfactory results. Unfortunately the clay-pit is now disused and is totally obliterated by being filled with waste from an adjoining mine.

The following is a list of the animals obtained from the clay-pit; and it is curious to notice, purely as a coincidence, how closely it can be compared with a similar list given by Mr. W. Baldwin[2] for the Sparth Bottoms Clay-pit:—

ARTHROPODA.

CRUSTACEA—

PHYLLOPODA: *Leaia trigonioides*, sp. nov.

SCHIZOPODA: *Præanaspides precursor*, Woodward.

MYRIAPODA:

Xylobius cf. *spinulosa*.

Xylobius sp.

Arthropleura, sp. nov.[3]

A. armata, Jordan.

INSECTÆ.

Insects' wings[4] with Blattoid and Lithomantid affinities. The latter, gen. et spec. nov.

[1] For list of plants found in this clay-pit see a paper by Mr. E. A. Newell Arber in the Proceedings of the Yorkshire Geological Society, vol. xvii, pt. ii, pp. 132–55, pls. xii–xix, 1910.

[2] W. Baldwin, "Fossil Myriapods of the Middle Coal-measures, Sparth": GEOL. MAG., Dec. V, Vol. VIII, p. 75, 1911.

[3] Professor Woodward has kindly undertaken to describe this specimen at a later date.

[4] Mr. H. Bolton has kindly undertaken to name and describe these wings at an early date.

ARACHNIDA—

XYPHOSURA :

Bellinurus bellulus, Koenig.
B. koenigianus, Woodward.
B. longicaudatus, Woodward.
B. sp.
Prestwichia anthrax, Prestwich sp.
P. rotundata, Woodward.
P. birtwelli, Woodward.

EURYPTERIDÆ :

Eurypterus moyseyi, Woodward.
E. derbiensis, Woodward.

SCORPIONES: Post-abdominal segment.

PEDIPALPI : *Geralinura britannica*, Pocock.

ARANEÆ : ? *Protolycosa* sp.

ANTHRACOMARTI :

Anthracosiro woodwardi, Pocock.
A. cf. *fritschii*, Pocock.

INCERTÆ SEDIS : *Cyclus* sp.

VERTEBRATA.

PISCES—

ELONYCHTHIDÆ : *Elonychthys* sp.

INCERTÆ SEDIS :

Fayolia cf. *dentata*, Zeiller.
F. crenulata, Moysey.
Palæoxyris prendeli, Lesquereux.
P. helicteroides (Morris).
Vetacapsula johnsoni (Kidston).

I would here desire to express my great obligation to Dr. Henry Woodward for assisting me in determining the specimens mentioned; also to Miss G. M. Woodward for the care and trouble she has taken in making drawings for the illustration of this paper.

V.—WHAT IS LATERITE?

By L. LEIGH FERMOR, A.R.S.M., D.Sc., F.G.S., Geological Survey of India.

(*Continued from the October Number, p. 462.*)

Detrital Laterite or Lateritite.—Many of the so-called low-level laterites and some of the high-level laterites consist of admixtures of detritus from the various varieties of laterite already mentioned, with quartz and argillaceous detritus from granites and gneisses, the whole cemented together by the action of water on the lateritic constituents of the mixture. For such rocks the name *detrital laterite* is available, and could be used in all cases in which the reconstructed rock contained, say, at least 40 per cent of lateritic constituents. Theoretically, detrital laterites may contain, as an upper limit, 100 per cent of lateritic constituents, corresponding to the case of a detrital rock composed entirely of fragments of a pure laterite, without admixture of extraneous constituents. From the above it will be seen that I would allow greater elasticity in using the term laterite for the detrital forms than for those formed in situ (see next paragraph), provided the adjective *detrital* be carefully prefixed; for this word seems to me to imply the great variability of composition that must characterize these *secondary laterites*. But if it were considered desirable to avoid the use of the word *laterite* altogether in this connexion, the obvious term to use instead would seem to be *lateritite*, implying *a rock the individual constituents of which are pieces of laterite*. This term would be of great utility, and could be applied to all detrital and reconstructed lateritic rocks. The word is put forward here merely as a suggestion, but if geologists were to distinguish, in writing, between *laterite*, *lateritoid*, and *lateritite*, great clarity could be introduced into the literature of these substances.

Limiting Percentages.—The difficulty in attaching names to rocks intermediate between pure laterite and pure clay or lithomarge is to fix on limiting percentages, which must be chosen more or less arbitrarily. Considering the case of a rock that had been analysed, I should say that not more than about 10 per cent of non-lateritic material (i.e. quartz or lithomarge, in ordinary cases) or 5 per cent of combined silica (10·72 per cent of lithomarge is equivalent to 5 per cent of combined silica) should be allowed to pass without prefixing to the term *laterite* a qualifying adjective, such as *quartzose* and *lithomargic* respectively. Material containing more than half its weight of either lithomarge or of quartz could no longer be called *laterite*, but might be called *lateritic lithomarge*, *sand*, *soil*, or *earth*, if there were a sufficient quantity of free oxides of iron and aluminium present to justify the use of the qualifying adjective. Fifty per cent of lithomarge of formula $2\,H_2O.\,Al_2O_3.\,2\,SiO_2$ corresponds to 23·25 per cent of combined silica. Considering that, in India, as a rule, impure laterites are more commonly predominantly lithomargic than quartzose, I should not allow any rock, the analysis of which showed over 23·25 per cent of SiO_2 *of undetermined character*, to be classed as laterite, assuming, in the absence of evidence to the contrary, that the silica was present in the combined condition. For *lateritite* or *detrital laterite* I consider that greater freedom should be allowed, as already explained, and that these terms might be allowed to include detrital lateritic rocks containing as much as 60 per cent of non-lateritic constituents.[1]

Analyses by H. and F. J. Warth.—To exemplify the application of this nomenclature, we may refer to the most complete series of analyses of laterites yet published, namely that made by Dr. H. Warth, formerly of the Geological Survey of India, and his son, Mr. F. J. Warth.[2] This paper gives twenty-three analyses, divided into four groups—

I. "Pure Gibbsite" (No. 1).
II. Bauxites rich in Al_2O_3 and poor in Fe_2O_3 (Nos. 2 to 5).
III. "Laterites in situ which are Bauxites" (Nos. 6 to 13).
IV. "Detrital Laterites" (Nos. 14 to 23).

Groups I to III are *high-level laterites*. Sample 1 is practically pure *gibbsite*. Samples 2 to 5 show 67·88 to 57·50 per cent of Al_2O_3, 4·09 to 6·53 per cent of Fe_2O_3, and only 0·93 to 2·35 per cent of SiO_2. They are, therefore, correctly designated *bauxites*, and can also be termed *aluminous laterites*.

Samples 6 to 13 show 54·80 to 26·27 per cent of Al_2O_3, 13·75 to 56·01 per cent of Fe_2O_3, and 0·37 to 4·29 per cent of SiO_2. They all, therefore, like the samples of Groups I and II, are *true laterites*, except No. 10, which contains 10·52 per cent of quartz, and should therefore be designated *quartzose laterite*, although it is only just above the limit for true laterite. The authors call the rocks of this group "Laterites . . . which are Bauxites"; in my opinion, however,

[1] It is interesting to note that as long ago as 1838 Dr. J. Clark divided lateritic rocks into the three following classes: (1) lithomargic, (2) quartzy, (3) detrital. See *Madras Journ. Lit. and Sci.*, viii, pp. 338, 344.

[2] GEOL. MAG., 1903, pp. 154–9.

Nos. 11 to 13, which contain 47·27 to 56·01 per cent of Fe_2O_3, are not entitled to the term *bauxite*, but should merely be termed *laterite* without any qualification, or, if so desired, *ferruginous laterite*.

Samples 14 to 23, comprising Group IV, show 35·70 to 6·67 per cent of Al_2O_3, 8·77 to 47·39 per cent of Fe_2O_3, 7·96 to 23·32 per cent of combined silica, and 4·53 to 39·53 per cent of free quartz. The authors re-arrange these analyses in terms of the mineralogical composition of the rocks they represent; the samples are thus shown to contain 39·94 to 64·56 per cent of my "lateritic constituents" (termed by the authors "Balance identical with Bauxite"), whilst the balance of 35·44 to 60·06 per cent of non-lateritic constituents is made up of 4·53 to 39·53 per cent of quartz, and 50·26 to 17·16 per cent of "Clay as Kaolin", with occasional extremely small amounts of CaO. The average composition of these ten "detrital laterites" works out as—

Lateritic constituents . .	49·85
Lithomarge	30·11
Quartz	19·99
	99·95
CaO	0·05
	100·00

or approximately: lateritic constituents 50 per cent, lithomarge 30 per cent, and quartz 20 per cent. They are, therefore, on the average just at the upper limit for laterite, and might be termed comprehensively *siliceous laterites*.

Taking these ten samples individually, however, differences are recognizable. They may be divided into two groups of five each. In the first group (Nos. 15, 16, 17, 18, and 20) there is a much greater proportion of lithomarge (29 to 50 per cent) than of quartz (4 to 17 per cent), whilst in the second group the quartz (24 to 40 per cent) is either approximately equal to or else is greater than the lithomarge (17 to 30 per cent). Of the former division, No. 17 from Jabalpur (? district) contains 50·26 per cent of lithomarge, and should therefore be termed *lateritic lithomarge*. It is interesting to note here that the Ponri Hill lateritic lithomarges referred to later also come from the Jabalpur district. The four remaining samples—from Belgaum (two), Dharwar, and Biridhum—show over 50 per cent of lateritic constituents, and should be termed *lithomargic laterites*. These five rocks, with the possible exception of the Dharwar sample containing 17 per cent of quartz, are not, I suspect, of detrital origin, as stated, but were probably formed in situ under conditions in which the lateritizing processes were not pushed to a finish.

The other five samples (Nos. 14, 19, 21, 22, and 23) all show over 50 per cent and under 60 per cent of non-lateritic constituents (with the exception of No. 23, which contains only 24 per cent of quartz and 20 per cent of lithomarge, and might be designated *siliceous laterite*, or even *argillaceous quartzose laterite*). Judging from the analyses, they are probably detrital rocks, formed perhaps by the admixture of detritus from lithomargic laterite deposits with

quartz sand, or by the admixture of detritus from true laterites with quartz and argillaceous detritus from gneissic or granitic rocks. The correct name for these rocks will be, then, *detrital laterite* or *lateritite*.

The Ponri Hill Lateritic Lithomarges.—As another example, I may refer to a series of superficial rocks found at Ponri Hill in the Jabalpur district, which I hope to describe later in the *Records of the Geological Survey of India* under the heading of *lateritic lithomarges*. On first examining this hill, I thought it was an occurrence of very aluminous laterite, and, consequently, took for analysis two bulk samples, representing the two principal varieties of the rock. I was much surprised, when the results of the analyses came to hand some three or four years ago, to see that the samples contained, respectively, 24·60 per cent and 31·90 per cent of SiO_2; but I at once decided that, in spite of their superficial resemblance to true laterite, both in physical appearance and in the case with which they could be cut into blocks for building purposes, these rocks could not be regarded as laterites. Closer inspection was sufficient to show that the groundmass of the rock consisted of a compact, somewhat horny, substance corresponding to the lithomarge, the presence of which was indicated by the analyses, and that the rock consisted of patches of lateritic material distributed through a lithomargic base. The analyses are given below, together with that of a third example, in this case a hand-specimen of a white pisolitic rock, collected by Dr. Maclaren at Mendil near Talevadi in the Belgaum district of the Bombay Presidency. The Mendil specimen was forwarded by me to Messrs. J. and H. S. Pattinson of Newcastle for analysis with my samples of manganese-ore, whilst I was Curator of the Geological Museum. Dr. Maclaren and I were both under the impression that this specimen was a piece of very high-grade bauxite, and had not the slightest suspicion of its siliceous nature. As will be seen from the following table, in which are given also the analyses of the samples from Ponri Hill, the Mendil specimen contains a very large amount of silica:—

	Ponri Hill.				Mendil.	
Number of Sample.	A. 13.		A. 14.		J.M.M.	
SiO_2	24·60		31·90		42·90	
Al_2O_3	28·04		30·98		39·20	
H_2O	12·50	98·29	12·65	98·77	14·13	99·07
Fe_2O_3	26·79		18·25		0·40	
TiO_2	6·21		4·79		2·34	
Mn_3O_4	0·15		0·20		0·10	
K_2O	0·01		0·01		nil	
Na_2O	0·13		0·19		0·09	
P_2O_5	0·16	1·46	0·19	1·48	0·17	1·03
CO_2	trace		trace		0·03	
Moisture	1·16		1·09		0·74	
	99·75		100·25		100·10	

Unfortunately the siliceous nature of these three rocks was not suspected at the time the samples were despatched for analysis, and consequently no instructions were issued to the analysts to determine separately the combined and free silica. There can be no doubt, however, judging from the microscopical examination, that practically all the silica is in the combined condition, for no evidence was seen of any free silica. These analyses have consequently been re-arranged in terms of their mineralogical composition on the following assumptions, which are fully justified in the light of the macroscopical and microscopical examination of the specimens. The whole of the silica has been calculated as lithomarge,[1] of the formula $2\,H_2O.Al_2O_3.2\,SiO_2$, and any alumina left over has been combined with the amount of the remaining water requisite for the formation of gibbsite. With the aid of any remaining water the ferric oxide is divided into limonite and hæmatite. The TiO_2 is returned as such, because little is at present known as to the form in which this constituent exists in laterite.[2] The item entered up by the analysts as 'manganese oxide' is assumed to have been determined as Mn_3O_4, and as it was not visible as a separate constituent in the samples, and is present in but very small quantities, it is reported as such in the mineralogical re-arrangement. The remaining constituents shown in the analyses are neglected, being trivial in quantity, and necessary neither for laterite nor lithomarge. The re-arranged analyses are as follows:—

		Poxri Hill.		Mendil.
		Lateritic lithomarges.		*Lithomarge.*
		A. 13.	A. 14.	J.M.M.
Lithomarge		52·75	68·40	91·99
Gibbsite	Lateritic constituents	11·05	6·10	4·24
Limonite		9·27	7·13	nil
Hæmatite		18·86 — 45·54	12·15 — 30·37	0·40 — 7·08
TiO_2		6·21	4·79	2·34
Mn_3O_4		0·15	0·20	0·10
Minor constituents (non-lateritic)		1·46	1·48	1·03
		99·75	100·25	100·10

[1] As seen under the microscope in thin sections, the aluminous silicate is isotropic wherever it shows any translucency or transparency, and it cannot therefore be designated kaolinite, which is a crystalline mineral. Substances corresponding to Dana's description of *lithomarge*, which he gives as a variety of kaolin, are invariably, in my experience, amorphous and non-crystalline, and consequently I think that lithomarge is to be regarded as the colloidal variety of kaolinite.

[2] Some authors assume its presence as ilmenite, e.g. Professor Harrison in his paper on the lateritic earths of British Guiana; but it cannot be present in this form in many of the Indian laterites. Reference to the analyses of aluminous laterites given in Rec. Geol. Surv. India, xxxii, p. 179, and xxxvii, p. 215, shows that in the majority of these laterites there is insufficient iron present for all the titanium to be in the form of ilmenite. Further, I have seen no evidence under the microscope of the existence of ilmenite in laterites, and, in fact, as far as I have seen, the high amounts of titanic oxide in some

Each of these three analyses shows more lithomarge than lateritic constituents, and consequently, according to what precedes, the Ponri rocks are most correctly described as *lateritic lithomarges*, whilst the Mendil specimen is a *lithomarge*, without any qualifying adjective.

Other examples.—For further examples amongst Indian laterites reference may again be made to the analyses referred to on p. 460. All the rocks represented by analyses in Dunstan's paper are correctly described as *laterites*, and can also be termed *aluminous laterites* or *bauxites*. The term *laterite* can also be applied without qualification to all the rocks represented by analyses in Holland's paper, with the exception of samples D, E, and G, containing respectively 14·58, 19·32, and 10·75 per cent of SiO_2. These silica percentages, assuming the whole of the silica to be combined silica, all lie above the 5 per cent limit given above, but below the 23 per cent limit, and the rocks should therefore be described as *lithomargic laterites*, the silica percentages corresponding to 31·26, 41·43, and 23·05 per cent of lithomarge; sample B, containing 4·68 per cent of SiO_2, corresponding to 10·03 per cent of lithomarge, is near the borderline at which I would prefix the adjective 'lithomargic'. These lithomargic laterites are all from the Madras Presidency, three of them coming from the Palni Hills and one from the Vizagapatam Hill Tracts.

Reference may also be made to three other analyses, namely, those of three aluminous laterites or bauxites from the Yeruli plateau, Satara district.[1] One of these contains 5·20 per cent of silica, and, therefore, assuming it is combined silica, as is probably the case, just comes within the limits of *lithomargic laterites*. Apart from this constituent, however, the rock is a fairly high-grade *bauxite*. The other two samples are true laterites, containing only 2·63 and 1·10 per cent of SiO_2 respectively. Noteworthy is the presence of 0·63 and 0·13 per cent of Cr_2O_3 in these two latter rocks; *chromium sesquioxide* must, of course, be regarded as a true lateritic constituent.

Lateritic earths.—For many mixtures of clay and sand with iron and aluminium oxides it is quite unnecessary to use the term *laterite* at all, more suitable terms being *ferruginous clay*, *loam*, or *sand*; where the free oxides are high in amount, the terms *lateritic clay*, *lateritic soil*, *lateritic earth*, etc., are available.

Buchanan's original definition.—It will be noticed that I have so far made no reference to Buchanan's original definition. This has

laterites do not make their presence evident in any form in thin sections of the corresponding rocks. Consequently I am inclined to think that the titania is present as a collodial constituent, either as a hydrated oxide of titanium, or even possibly as a hydrated aluminium titanate, of composition parallel to that of kaolin and lithomarge, although this latter alternative is put forward as a mere suggestion, for which there is at present no evidence. Whether the titania be present as a hydroxide or as a collodial titanate does not matter for our present purpose, as the above analyses are susceptible of arrangement to agree with either alternative. I find that M. Arsandaux (note, *infra*) supposes the titania of French bauxites to be present as metatitanic acid, TiO_2, H_2O.

[1] Mem. Geol. Surv. India, xxxvii, p. 378.

already been quoted by Mr. Crook,[1] whilst Dr. Evans[2] puts the matter in a nutshell when he says—

"'Buchanan found a rock widely extended in India which was unlike anything with which he was familiar, and he thought that it required a name. As bricks were made of it (not because it resembled a brick) he called it laterite, certainly without intending to include under it all materials of which bricks could be made. I admit that he did not know its true chemical composition, but in spite of that it must be accepted as the type of what we ought to call laterite."

Buchanan's term was adopted by Indian geologists, and has been widely applied in many parts of India; laterite has consequently been described in very numerous papers on Indian geology,[3] but until the last few years without much knowledge on the part of the authors of the chemical composition of the rock; it follows, therefore, that this term has sometimes been applied to rocks that, had they occurred in a temperate clime, would have been called by some more ordinary name, such as clay, lithomarge, iron-ore, etc.

Mr. Philip Lake, in the Appendix to his memoir on the *Geology of the South Malabar*,[4] says—

"Some writers appear to restrict the term to rock formed in some particular way, and to exclude all laterite rocks that can be shown to have originated in any other manner. But the name, as originally proposed by Buchanan, appears to have been a pure lithological term, for he does not discuss the mode of origin. If any rock is, in hand specimens, undistinguishable from laterite, there is no reason why it should not be called laterite whatever its mode of origin may have been.

"Other writers, on the other hand, have used the term too laxly, and have called rock laterite which should rather be called *lateritic*;[5] but it must be admitted that it is hard to draw a line between laterite containing pebbles and a conglomerate in which the pebbles are cemented together by laterite."

As long as no chemical work had been carried out on laterite it was necessary to accept Lake's view that any rock indistinguishable from laterite in hand-specimens should be called by this name. But now that we have chemical information on the composition of these rocks it seems necessary to use more discrimination, and in refusing the term *laterite* to lithomarges, and in advocating the qualification by the adjective *lithomargic* of those laterites containing considerable quantities of this mineral, we shall be acting in spirit with Buchanan, who would not have wished to comprise under one term such dissimilar substances as lithomarge and the mixture of hydrated oxides to which the term *laterite* should be restricted; we are also not departing far from Lake's view, for when once one has established by the aid of analysis the difference between true laterites and those containing a considerable quantity of lithomarge, and between both of these and rocks that are almost wholly lithomarge, it is easy in most cases to recognize the differences in hand-specimens; in any case it is not difficult to make a qualitative test for combined silica in any doubtful case.

[1] Geol. Mag., 1909, p. 525. [2] Loc. cit., 1910, p. 381.

[3] Résumés of this work and of that of other previous writers are to be found in the following works: P. Lake, "Geology of South Malabar," Appendix (Mem. Geol. Surv. India, xxiv, pp. 239–46, 1891); G. C. Du Bois, "Beitrag zur Kenntnis der surinamischen Laterit, etc." (Tschermak's Mitt., xxii, pp. 4–18, 1903); C. Guillemain, "Beiträge zur Geologie von Kamerun" (Abh. König. Preuss. Geol. Landesanstalt, N.S., vol. lxii, pt. viii, on Laterite, pp. 242–323).

[4] Mem. Geol. Surv. India, xxiv, p. 239, 1891. [5] The italics are mine.

TABLE I.—THE NOMENCLATURE OF LATERITES AND SOME OTHER SURFACE ROCKS.

Chemically-formed rocks.							Transported rocks (mechanically formed).[1]		
Original rocks.	Mode of formation.	I. Lithomarge, clay, soils, etc. <25 % L.C.	II. Lateritic rocks. 25–50 % L.C.	III. Siliceous laterites (and lateritoids). 50–90 % L.C.	IV. True laterites (and lateritoids). 90–100 % L.C.	V. Varieties of IV.	Original rocks.	VI. Detrital laterites (lateritite). 40–100 % L.C.	VII. Soils and lateritic earths. <40 % L.C.
Basic rocks—Basalts, dolerites, gabbros, basic gneisses, hornblende-schist, etc.	Weathering in situ.	**LITHOMARGE, CLAY**, soils, sands, earth, and partially decomposed rocks.	*Lateritic lithomarge* and clay. Lateritic soil.	**Lithomargic laterite.**	**True LATERITE.**	Bauxite, iron-ore, manganese-ore.	Any of Groups I to V, alone, or mixed with extraneous material.	**DETRITAL LATERITE (Lateritite).**	Clays, soils, sands, earths, etc. *(lateritic*, if 25–40 % L.C.).
Acid rocks—Granites, gneisses, mica-schists, etc.			*Quartzose lateritic lithomarge.* Lateritic soil.	**Quartzose laterite.** (sometimes lithomargic as well).					
Any rocks that yield iron (manganese and aluminium) to meteoric waters.	Chemical deposition in lakes.	...		Siliceous lake laterites.	**LAKE LATERITE.**	Pisolitic limonite, (manganese-ore), (bauxite).			
Mica-schists, quartzites, etc.	Metasomatic replacement.	Quartzites and schists become mixed with Fe and Mn oxides, and pass into *lateritoid 'breccias'* and these into III.		*Quartzose and sericitic lateritoids.*	**LATERITOID.**	Iron-ore, manganese-ore.			

NOTE. L.C. denotes 'lateritic constituents'.

[1] Frequently with cementing by chemical rearrangement of the lateritic material.

Table.—The conclusions drawn above on the nomenclature of laterites are summarized in the accompanying table, which is self-explanatory. The limits between the various groups have, of course, been arbitrarily fixed, and might be adjusted to suit local convenience, but not to any serious extent.

Lateritoid.—Through manganese-ores and iron-ores, the laterites are related to the rocks I have called *lateritoid*, shown in the lowest line of the table, and as I consider it rather important to distinguish between those two related rocks I will quote in full my original account of lateritoid [1]—

"Of the many occurrences of lateritic manganese-ores that I have been able to examine, only three were in what would be called 'laterite', without any hesitation, by all geologists. These three were in the low-level laterite of Goa; in the high-level laterite of Talevádi in Belgaum; and near Gosalpur in the Jabalpur district in laterite that must, I suppose, be called 'high-level', although it is only at a level of about 1,300 to 1,400 feet. The remainder occur in a rock that some geologists would probably designate 'laterite'; but others would probably object to the application of the term. The rock to which I refer has a lateritic aspect and usually consists of a cavernous mixture of various oxides of iron, chiefly hard limonite, yellow ochre, and soft hematite. When no other constituents are present, the rock often resembles typical laterite in its structures and mineral composition so closely that when detached from its rock masses it could not be distinguished from pieces of ordinary ferruginous laterite (of non-detrital origin). Fairly often, however, it contains ores of manganese, either wad, psilomelane, or pyrolusite. The iron-ores and manganese-ores are mixed with one another in a very irregular manner. Veins and patches of the manganese-ores sometimes occur in the iron-ores, whilst in other places veins and patches of iron-ores occur in a mass consisting chiefly of manganese-ores. Owing to the cavernous character of the rock the limonite and psilomelane have often been able to develop marked concretionary structures, such as botryoidal or stalactitic, whilst the pyrolusite is often in small crystalline aggregates. This rock does not always consist entirely of iron and manganese-ores. It often contains patches of quartz, quartzite, slate, or phyllite. Examination with the microscope shows that these rock-patches are residual pieces of rock set in a matrix of ore, and that the latter has evidently been formed by their replacement. Examination of the masses of rock in the field, especially as revealed in the workings for manganese, confirms this deduction, and shows that there is a downward passage from the lateritic mass of iron and manganese-ore at the surface through rock containing more and more quartzite, slate, or other rock, and less and less ore, to a rock that is free from all signs of ore. The junction between the overlying lateritic mass of rock and the rock on which it rests is consequently an extremely irregular one. There is, in my opinion, no doubt that these lateritic masses have been formed by the metasomatic replacement of the quartzite, slate, or phyllite, accompanied by segregative changes. And as these rocks do not usually contain more than a very small proportion of, and often no, manganese, it is evident that the manganese must have been largely brought in from outside by percolating waters, with the resultant replacement from the surface downwards of the particular rock that happened to be at the surface where the replacement took place. These lateritic replacement deposits nearly always occur as cappings to small hills, the actual rugged surface of the rock (often spotted with lichens) being approximately horizontal. These caps do not, however, show signs that they are the remains of a horizontal sheet, for they occur at different elevations on neighbouring hills, and as noticed above have a very irregular base. And although there are doubtless many cases where such a cap has been cut into two by erosion, yet most of the occurrences suggest that they have been formed

[1] Mem. Geol. Surv. India, xxxvii, pp. 381–3, 1909.

independently of other masses of this lateritic rock. On account of the limited extent of each of these masses of rock, their different elevation, their want of horizontal bases, and the numerous cases in which the rock contains residual angular fragments of other rocks, most geologists would probably prefer to consider these occurrences as distinct from the masses of typical laterite occurring in horizontal sheets, often of considerable extension, and free from included fragments of rock different in character from the laterite. For this reason I propose to refer to these occurrences under the name of *lateritoid* to indicate their similarity to laterite. It is to be noted that, were they to be designated 'laterite', they would by their position come into the high-level laterite division. From what I have written above it is evident that my view of the origin of these masses of lateritoid and their included manganese-ores is practically identical with Maclaren's theory of the origin of laterite in general. He bases his theory particularly on the occurrence at Talevádi in Belgaum. I have visited this occurrence myself, and although the sections were no longer so good as when Maclaren went, yet I saw sufficient to make me agree with his description of the occurrence. Although the occurrence was in an area where the laterite seemed to occur as a large spread, yet I could not see any difference between the mode of occurrence of the manganese-ores here and those in the lateritoid deposits. From this it will be seen that the Talevádi occurrence may be regarded as a connecting link between the lateritoid caps containing manganese-ores and the large spreads of high-level laterite usually free from manganese-ore. I think, however, it is more closely related to the lateritoid occurrences than to the large spreads of high-level laterite in which bauxite is so often found."

(*To be concluded in the next Number.*)

NOTICES OF MEMOIRS.

I.—Jurassic in the Western Caucasus.

[Translated from the Russian by Felix Oswald, D.Sc., B.A., F.G.S.]

ALTHOUGH Jurassic strata reach a very extensive development in Daghestan and in the Central Caucasus, it is only within recent years that Russian geologists (N. I. Vorobiev in 1906, I. P. Tolmachev and M. Volosatov in 1907) have definitely proved the existence of Middle Jurassic beds in the western part of the Caucasus, viz. in the valley of the Little Laba, in the Psebai district (Maikop division of the Kuban province), where they overlie the Triassic strata described in the Geological Magazine, Dec. V, Vol. VI, No. 538, pp. 171–3, April, 1909. The fossils (now in the Peter the Great Museum at St. Petersburg) have been determined by B. Rebinder in a paper written in Russian ("Trav. Mus. géol. Pierre le Grand, St. Petersb.," ii, pp. 53–60, 1908), which I have translated and briefly summarized in the following abstract.

The Jurassic of the Little Laba valley extends for 3 miles below Psebai, forming the line of the Gernegem Heights, which are traversed and partly dissected by the Little Laba and its small tributaries. The valleys of these tributary streams are named in successive order from north to south: Lazaret, Marin, Sushkov, Vorov or Razboinich, and Solen. The general slope of the country roughly coincides with the north-east dip of the Jurassic strata, and hence the limestones rise to increasingly greater heights when traced southwards towards Psebai, so that in the southernmost of the tributary valleys, viz. Lazaret, the underlying series of shales with sphærosiderite nodules is exposed beneath the limestones, which form craggy heights, liable to

slip over the clays. In the more northern valleys the limestones occur in the bed of the valleys, and are there overlain by a very thick series of clays with gypsum, apparently of Miocene age. Above Psebai the Little Laba cuts through a thick series of sandstone (with plant-remains) underlying the shales and resting upon Triassic limestones.

The Jurassic succession of the Little Laba valley may be thus tabulated from Rebinder's lists:—

1. *Oxfordian and Sequanian.*—Light brownish grey limestones, very fossiliferous, with an assemblage in which Oxfordian forms predominate, but there is a sprinkling of Lower Sequanian species such as *Zeilleria pseudolagenalis*, *Terebratula Zieteni*, and *Balanocrinus pentagonalis*, *Phylloceras*, sp. ind., *Peltoceras* cf. *arduennense*, d'Orb., *Perisphinctes bernensis*, Lor., *P. consociatus*, Buk., *P.* cf. *lucingensis*, Favre, *P. mazuricus*, Buk., *P.* cf. *Michalski*, Buk., *P.* cf. *tizianiformis*, Choff., *P.* aff. *plicatilis*, d'Orb., *P.* aff. *biplex*, *Dentalium*, sp. ind., *Ceromya excentrica*, Boem.,* *Lima Escheri*, Moesch, *Hinnites velatus*, Gf.,* *Plicatula*, sp. ind., *Terebratula Rollieri*, Haas, *T.* cf. *Zieteni*, Lor., *Zeilleria pseudolagenalis*, Moesch, *Waldheimia*, sp. ind., *Dictyothyris*, sp. ind., *Rhynchonella lacunosa*, Qu.,* *Holectypus*, sp. ind., *Pentacrinus cingulatus*, Münst., *P.* cf. *Marcousanus*, d'Orb., *Balanocrinus pentagonalis*, Gf., *Millericrinus* cf. *icaunensis*, Lor., *M. Escheri*, Lor.,* *Serpula*, sp. ind., and sponge-fragments. Those marked with an asterisk pass also upward into the Sequanian.

2. *Bathonian and Callovian.*—Yellow-grey to rusty-brown sandy limestones, yellow-grey oolitic limestones with geodes of limonite, and sandstones, sometimes argillaceous, with the following Bathonian forms occurring in the limestones: *Belemnites* aff. *canaliculatus*, Schl., *B.* cf. *würtembergensis*, Opp., *B.* aff. *Jacquoti*, Terq. & Jourdy, *Pleuromya donacina*, Röm., *Pseudomonotis*, sp. ind., *Gervillia*, sp. ind., *Rhynchonella varians*, Sow., var. *spathica*, Desh., *Terebratula* aff. *sphæroidalis*, Sow., *T. sphæroidalis*, Sow., mut. *balinensis*, Szajn., *T.* cf. *rentricosa*, Hartm., *Cidaris filograna*, Ag.

In this series the presence of Callovian (*Macrocephalus* zone) is clearly indicated by the following fossils: *Stephanoceras coronatum*, Brug., *Quenstedticeras*, sp. ind., *Pecten fibrosus*, Sow., *Cyclocrinus macrocephalus*, Qu.

3. *Bajocian.*—(i) Dark-grey shales with nodules of sphærosiderite (up to 0·20 m. in thickness), which frequently contain ammonites. The following fossils were obtained from this series: *Belemnites giganteus*, Schloth., *B.* aff. *paxillosus*, Qu., *Parkinsonia Parkinsoni*, Sow., *Pœcilomorphus* aff. *macer*, Buckm. (ii) Sandstones with plant-remains, overlying Triassic strata. A seam of lignite, 7 inches thick, has been recorded from these beds, in the Kizilovaya valley near Psebai.

The entire palæontological succession is closely parallel to that of Khod near Alagir on the north slope of the Central Caucasus, about 80 miles to the south-east.

Rebinder expresses strong doubts as to the presence of Kimeridgian in the Jurassic of the Little Laba, for in his lists the only species which range so far upwards are *Ceromya excentrica*, *Terebratula* cf. *Zieteni*, and *Zeilleria pseudolagenalis*, but these are all more characteristic of a lower horizon. Moreover, it would indeed be a matter for surprise

if Kimeridgian fossils had been discovered, for the Kimeridgian was not a period of deposition in the Caucasian area but one of earth-movements and folding of strata. It is one of the sharpest distinctions between the stratigraphy of the two slopes of the Caucasus that whereas on the south slope the interruption takes place only after the Sequanian and lasts until the Neocomian, on the north slope on the other hand Tithonian beds are well developed and rest discordantly on Lower Sequanian.

II.—The Glacial Period and Climatic Changes in North-East Africa.[1]

By W. F. Hume, D.Sc., F.R.S.E., and J. I. Craig, M.A., F.R.S.E.

1. *Southerly Shift of the Wind-systems in Glacial Times.*—The effect of the seasonal decrease of temperature in the Northern Hemisphere is to cause a seasonal displacement of the system of westerly moist winds southwards by several degrees, and not improbably decrease of temperature below its normal is also associated with a similar displacement. It is inferred that the decrease of temperature of the Glacial Period would be correlated with such a displacement of the westerly winds, which now barely touch the north coast of Egypt in the winter, that they would impinge on the loftiest portion of the Red Sea mountain range.

Geological and topographical evidence points conclusively to the existence of such a westerly moist current at no very distant period. The current was westerly, for the principal erosion occurred on the western slopes, and this erosion is evidenced by the gravel terraces, which attain a remarkable development near the town of Qena. These consist of materials which could have come only from the highest portion of the Red Sea Hills, distant some 40 to 50 miles to the east or north-east. The precipitation was most active where the range is highest, and decreases towards the north where the mountains are lower. The decrease towards the south is to be attributed more probably to an approach to the southern limit of the moist current.

Further evidence of such a westerly current is to be found in the existence of calcareous tufas on the border of the eastern scarp of Kharga Oasis and elsewhere, and that the temperature was then several degrees colder is shown by the presence in the tufas of leaf-fragments of *Quercus ilex* and other plants which do not now flourish south of Corsica and Southern France.

2. *Change in Monsoon Effects during the Glacial Period.*—There is evidence of the enormous development of glaciers over Ruwenzori, Mount Kenia, Kilimanjaro, and the Himalayas, during the Glacial Period. The recession of the glaciers in East Africa indicates that the temperature there is now about 10° to 12° F. warmer than during the period of maximum glaciation.

It is known from the investigations of the Meteorological Department of India that an increased snowfall on the Himalayas in spring exercises a measurable prejudicial effect on the Indian monsoon at the

[1] Read before Section C (Geology), British Association, Portsmouth, September, 1911.

present day, and we may infer that the enormously greater ice-covering of the Glacial Period would exercise a much more powerful inhibition on the monsoon of that period. The more extensive ice-sheet of East Africa, by preventing abnormal heating of the land in summer, would act still further in the same direction, and it is extremely probable that the monsoon current partook of the southerly displacement of the wind-system referred to above. The general result would be a decreased precipitation over Abyssinia, and a much reduced Sobat, Blue Nile, and Atbara, which at present account for 96 per cent of the flood proper of the Nile.

The geological history of the Nile entirely accords with the above inferences. One of the chief results of the present monsoon rainfall has been the deposit of finely divided muds brought from the Abyssinian hills, in the Nile valley. To the south of Cairo these deposits are at most of 30 to 35 feet thickness, of which 10 feet have been laid down since the time of Ramses II. If conditions have remained uniform, this would give a date fourteen thousand years ago for the first deposits of alluvial muds in Egypt. Previous to this the mud-laden waters of the Abyssinian Nile system did not reach Egypt, just as the waters of Khor Gash now fail to reach the Nile, and so geology and meteorology concur in indicating a much weaker rainfall in Abyssinia during the Glacial Period.

III.—Index Generum et Specierum Animalium.[1]

Report of the Committee, consisting of Dr. Henry Woodward (Chairman), Dr. F. A. Bather (Secretary), Dr. P. L. Sclater, the Rev. T. R. R. Stebbing, Dr. W. E. Hoyle, the Hon. Walter Rothschild, and Lord Walsingham.

SINCE the 1910 Report systematic search through literature has proceeded up to the letter E. Further, a group of especially troublesome and difficult books have been dealt with, e.g.: Oken's *Isis*, 41 vols., 1817–48; Froriep's *Notizen*, 102 vols., 1821–50; Ersch & Gruber, *Allgem. Encyclopaedie*, 103 vols., 1818–50; and many other volumes have been indexed out of the general order as asked for or required—as, for instance, the works of Jacob Huebner, which are now in Mr. Sherborn's hands in hope that he may obtain some further information as to the dates of their publication.

The search for rare literature continues, and Mr. Sherborn desires to thank Dr. Karpinski for obtaining for him the second volume of the *Trudui* of the St. Petersburg Mineralogical Society, 1831; Dr. Bashford Dean and Mr. O. F. Cook for a complete set of *Brandtia*, 1896–7, both of which works will find a resting-place in the British Museum (Nat. Hist.) when done with. He also desires to thank Mr. Tom Iredale for much valuable help in obscure bird genera.

The following papers have been written in connection with the Index:—

"On the Dates of Publication of Costa's *Fauna del Regno di Napoli*, 1829–86": Ann. Mag. Nat. Hist. (8), v, p. 132, 1910.

"A Collation of J. C. Chenu's *Illustr. Conch.*, and a note on P. L. Duclos' *Hist. nat. gén. et part. coquilles*" (with Mr. Edgar A. Smith): Proc. Malac. Soc., ix, March, 1911.

[1] Read before Section D (Zoology), Brit. Assoc., Portsmouth, September, 1911.

"Note on John Curtis' *British Entom.*" (with Mr. J. Hartley Durrant): Entom. Month. Mag., xlvii, April, 1911.

Your Committee confidently recommend their reappointment, and earnestly ask the Association further to support this valuable work by a renewed grant.[1]

IV.—On some New Rhætic Fossils from Glen Parva, Leicestershire. By A. R. Horwood.[2]

OWING to the impending filling up of the once fine pit at Wigston (Glen Parva), where the Keuper tea-green marl, Rhætic, and Lias formations are all exposed in a fine section of some eighty feet of rock, extraordinary efforts have been made by Messrs. A. J. Cannon and H. Siddons to investigate the contents of the bone-bed and black shales of the Rhætic before this is rendered impossible by the filling up of the pit with water, the brickyard being now closed.

Some rare and new fossils have been found which may here be briefly mentioned. In the tea-green marls *Orbiculoidea Townsendi* was discovered. This, along with the regular occurrence there of bands of fish scales and teeth in the same beds, and of *Estheria minuta*, allies them palæontologically with the Rhætic beds in which alone the first fossil has hitherto been found.

In the succeeding black shales amongst many plant fragments are some leaves allied to *Podozamites*, which are new. An exceedingly interesting discovery is the impression, unique as such for Palæozoic or Mesozoic rocks, of an annelid which occurs in beds filled with castings allied to *Arenicola*. Among Arthropodous remains are the chitinous body-segments of Crustacea and a scorpion-like creature. That they are not uncommon elsewhere is probable. But the Rhætic fauna is so fragmentary and generally so depauperated and stunted that the most careful search is required.

Ophiolepis Damesii, not definitely found in situ here before, has occurred, and with it some other Echinoderms which may be new. Many fine examples of *Pholidophorus Higginsi* have been secured which exhibit the dermal armature well, and also the fins. Some curious concretionary structures, homœomorphs of orthoceratoid segments, occur here also. The usual fauna already described has been obtained, some fine examples of each species having been collected. It is hoped to describe the new forms very shortly.

V.—On the Discovery of Remains of *Iguanodon Mantelli* in the Wealden Beds of Brighstone Bay, I.W., and the Adaptation of the Pelvic Girdle in relation to an Erect Position and Bipedal Progression. By R. W. Hooley.[2]

THE specimen of which the paper treated was discovered by the author in 1899; it includes the sacrum, lumbar, and caudal vertebræ, bones of the pelvic girdle, and the left femur. The

[1] A further grant of £75 was made at the Portsmouth Meeting, and Dr. W. T. Calman was added to the Committee.

[2] Read before Section C (Geology), British Association, Portsmouth, September, 1911.

characters shown by the fossil prove the remains to belong to *Iguanodon Mantelli*, but all examples hitherto found have manifested this species to be much smaller than *Iguanodon Bernissartensis*, whereas the bones discovered belonged to a reptile equalling, if not exceeding, the dimensions of that species. Among the skeletons of Iguanodons found at Bernissart in 1878, M. Dollo found a small and a large form. The former resembled in all points the type-specimen of *Iguanodon Mantelli*, and he thought that the differences between the two forms were specific and not sexual. This specimen opens the question again, and the author criticized the evidence, and inclined to the opinion that the osteological variations are sexual and that *Iguanodon Bernissartensis* is probably a synonym of *Iguanodon Mantelli*.

The second part of the paper dealt with the adaptation of the Iguanodont pelvis to enable an upright position and progression, and discussed the variations in the Dinosaurian pelvis.

REVIEWS.

I.—Iron Mines and Iron Mining in New Jersey. By William S. Bayley. [Vol. VII of the Final Report Series of the Geological Survey of New Jersey; Henry B. Kümmel, State Geologist. Trenton, N.J., 1910.]

THE object of this Report is to record in one volume the principal facts relating to the distribution and mode of occurrence of the iron-ores in the State. The records scattered through forty volumes of Annual Reports have been examined and utilized wherever expedient. The history of every mine, so far as known, has been briefly mentioned, and practically every iron-working has been visited. The commercial analyses have been tabulated and more complete ones have been added. The volume in short contains a most valuable summary, including much new information, of all that is known of the New Jersey iron-ores, with references also to opinions concerning their origin.

The ores comprise Bog Iron-ores, Brown and Red Hæmatites, and Magnetic Iron-ores. The history of the mining dates back to 1685, soon after English settlers first entered the borders of the State. The Bog Iron-ores were then worked. They comprise impure hydrated oxides, accumulated in bogs and swampy places where iron-bearing solutions were exposed to the action of the atmosphere. It is noted that within recent years the ore has met with some favour as a road metal, "a use to which it is well adapted when properly mixed with sand."

Brown Hæmatites or Limonites have been worked to a small extent, chiefly in the Kittatinny Limestone of the Cambrian, in cracks and in lenticular masses along bedding-planes of the strata, near their contact with the underlying gneisses. At the Edsall Mine the ore appears to be in the white Franklin Limestone of the Algonkian, near its contact with gneisses. Elsewhere it has been found in Cambrian slates and quartzites. It has nowhere been worked to any large extent.

Still less has the Red Hæmatite been worked. It occurs in shaly

rocks, quartzites, and quartzose conglomerates associated with the Franklin Limestone.

The chief ores worked are the Magnetic ores or Magnetite-bearing rocks, and these are associated either with the white or grey crystalline limestone or marble of the Franklin formation, or with the gneisses and pegmatites. It is inferred that these latter are the younger, and were intruded into the Franklin formation.

The production of iron-ore was estimated at 10,000 tons in 1790; the largest yield, 932,762 tons, was in 1882; and in 1908 the yield was 432,566 tons, almost entirely magnetic iron-ore.

The volume is accompanied by two geological maps (scale 1 inch to a mile) of the eastern and western sections of the New Jersey Highlands, showing the distribution of the principal types of Pre-Cambrian rocks and the localities of iron-ore deposits.

II.—Prehistoric Society of East Anglia.

THE first part of the Proceedings of this Society for 1908–10 has lately been issued (H. K. Lewis, 136 Gower Street, W.C., 1911, price 3*s.* 6*d.* net), under the editorship of the Honorary Secretary, Mr. W. G. Clarke.

Among other articles it contains a paper on "The Flint Implements of Sub-Crag Man", by Mr. J. Reid Moir. He claims to have found "definitely well-worked flints (which are far in advance of the Kentian Eoliths) in their true stratigraphical position below Crag". The deposit in question is that grouped by Mr. F. W. Harmer as the Newbournian zone of the Red Crag. The flints have been found under shelly crag, 13 feet and more in thickness, at Greenwich Farm and the Black Hamlet, Ipswich, and at Thorington Hall, Wherstead. Mr. Whitaker, Dr. Marr, and Professor Watts visited the Thorington Hall pit with Mr. Moir and pronounced the strata to be in situ. In another section, at the Brickyard of Messrs. Bolton and Laughlin north of Christchurch Park, Ipswich, worked flints were found on a surface of London Clay beneath a basement stone-bed of the Red Crag, with phosphatic nodules, bones of whale, mastodon, etc. Here, again, Mr. Whitaker and Dr. Marr express the opinion that the stone-bed "is the undisturbed base of the Red Crag". The London Clay below and in other parts of the pit exhibits much contortion and some evidence of thrust-planes, and the same authorities admit that the disturbances are due to ice-action, "although no such disturbance has affected the relative position of the London Clay, the Crag, and the Glacial Drift." The carefully drawn diagram by Mr. George Slater, however, does not lend support to this view, as a portion of the basement crag is represented as incorporated with the Boulder Drift. We are not, therefore, surprised to read that Professor Bonney came to the conclusion that the Crag deposits in the brickyard "are not in situ, but owe their present position to later geological disturbances". It is noteworthy that on the surfaces of the sub-crag flints there are striations attributed by Mr. Moir to ice-action, and he concludes that we may have "to recognize a glaciation in early Pliocene or pre-Pliocene times".

With regard to the flints themselves, of which illustrations are given in six plates, the evidence of man's work is recognized by Sir E. Ray Lankester, Dr. Blackmore, Dr. W. Allen Sturge (President of the Society), Dr. F. Corner, Mr. A. S. Kennard, and others; while Professor Boyd Dawkins and Mr. S. Hazzledine Warren regard the flakings as the result of natural forces.

The record of facts and the inferences are very carefully and fairly stated by Mr. Moir, and his paper is followed by the Report of a Special Committee of the Society appointed to inquire into the question whether the flints had been chipped by natural or by human agency. The verdict was in favour of human agency.

III.—Flora of the Little River Group, No. III. By G. F. Matthew, D.Sc., LL.D. Trans. Roy. Soc. Canada (III), vol. iv, sect. iv, p. 3.

THIS paper gives an "Analysis of the flora of the Little River Group, with Description of *Pseudobaiera*". In it Dr. Matthew has separated the plants of this formation from those taken from Gaspé and other Devonian localities, to show the special types that characterize the Little River Group. Thus isolated, they are seen to have a facies remarkably like that of the usual groupings of Coal-measure plants, with which they have been confounded by several specialists. But in this case the stratigraphy, Dr. Matthew asserts, shows that they must be much older than the Carboniferous age. He claims that the genera *Pseudobaiera*, *Ramicalamus*, *Lepidocalamus*, and *Ginkgophyton* are not known in strata more recent than the Little River Group; the first and last of these genera are Pteridosperms, while the other two belong to the Equisetaceæ. Certain filicoid genera are also common in this group—*Aneimites*, *Neuropteris*, *Pecopteris*, *Megaphyton*, etc. *Psilophyton* occurs, but not the typical forms described by Dawson from the Devonian of Gaspé, etc.

A revised list of the species of plants of the Little River Group described by Sir William Dawson is given, together with notes on the several species, and quite a number are claimed to be Pteridosperms on the basis of their resemblance to Carboniferous filicoid genera that have been shown to be seed-bearing.

The closing part of the article is devoted to a redescription of *Pseudobaiera* as represented by *P. McLatoshi*. Additional material has been obtained which shows more fully both the vegetative and fruiting branches or shoots; the former are more typically filicoid than those first obtained, and the latter show examples of the mature as well as the young fruit or fruit pods.

Even with the plants of the Little River Group excised the Devonian flora of Eastern North America shows no less than forty species, mostly described by Sir William Dawson, and furnished by localities extending from Pennsylvania to Gaspé. *Psilophyton*, *Lepidodendron* (with small areoles), and *Archæopteris* are genera which are most markedly characteristic of the Devonian age.

IV.—Draysoniana: being an attempt to explain and popularise the system of the second rotation of the earth as discovered by the late Major-General A. W. Drayson, F.R.A.S. By Admiral Sir Algernon F. R. De Horsey, K.C.B. 8vo; pp. ix, 76, with numerous diagrams. London: Longmans, Green, & Co., 1911. Price 3*s.* 6*d.* net.

IN 1871 Drayson read before the Geological Society a paper "On the probable Cause, Date, and Duration of the Glacial Epoch of Geology". This was published in abstract, and the author concluded that "about 21,000 years ago the climate would become more and more extreme up to about 15,000 years ago, and then gradually more and more equable to about 6,000 years ago". These estimates appear to have undergone subsequent revision, as Admiral De Horsey remarks (p. 69) "that among the results of Drayson's discovery is the geometrical proof that the glacial period lasted only about 16,000 or 18,000 years, and terminated about 7,500 years ago". It is not right to say that "nearly all geologists in America and England have from geological evidence found that the dates given by General Drayson about thirty years ago were absolutely accurate". Prestwich's estimates of 1887 agree approximately with those of Drayson, and it is true that there has been a disposition to adopt lesser estimates for the duration of the Glacial epoch than those of thirty or forty years ago. *Draysoniana* deals mainly with matters astronomical.

V.—Brief Notices.

1. St. Albans and its Neighbourhood.—Under this title the Hertfordshire Natural History Society has reprinted from its Transactions and issued as a pamphlet (price 2*s.* net, Dulau & Co., 1911), a report that had been specially compiled by members of the Society for use during the Sixteenth Annual Congress of the South-Eastern Union of Scientific Societies. The report contains an account of the Topography, Geology, Hydrology, Climate, Flora, Fauna, and Archæology of the district, with a guide to the Hertfordshire County Museum. It is edited by Mr. John Hopkinson, who has contributed a concise account of the geology, as well as several other articles, the area described being a radius of 5 miles from the Town Hall at St. Albans. The work is accompanied by several topographical maps and pictorial views.

2. In a pamphlet entitled *The Stone Age and Lake Lothing* (Norwich, Norfolk News Co., 1911), Mr. J. Chambers describes an excavation made recently in the bed of the channel which lies between Oulton Broad and Lowestoft Harbour. The section showed, beneath the harbour mud, "a bed of peat about 2 feet thick. Below this about 5 feet of sand. In the middle of this sand was a layer of vegetable-looking mould 1½ inches thick. On this were roots of bushes, the branches of which, well-preserved, penetrated the sand above. These roots would be 4 to 6 feet below low-water mark. Below the sand was a bed of coarse gravel 2 or 3 feet in thickness, in which flint implements were found. And below this was sand like that of the sea shore." The implements are not figured, and they appear to be

simply chipped flints. The author mentions that he has "found some in the Crag, London Clay, Reading Beds, and in the Chalk below them". From his descriptions we can form no opinion with regard to the particular flints found in Lake Lothing. Great part of the pamphlet is taken up with a discussion on topographic changes and the etymology of local names.

3. At the meeting of the Lake Superior Mining Institute, held on August 22, 1911, a paper on "A Diamond Drill Core-Section of the Mesabi Rocks", in Minnesota, was read by Professor N. H. Winchell, of Minneapolis.

In the Proceedings of the Institute for the years 1908–10 the author presented evidence to show that in Minnesota volcanic igneous rock composes a large proportion of the strata usually termed 'Animikie', which also specifically may be designated *Mesabi*.

In 1899, towards the close of the Minnesota Geological Survey, some evidence of the nature of the iron-bearing rocks of the Mesabi range was met with, and it was presented in the final report (vol. v), where its purport was fully set forth. It was suggested that if a careful examination were to be made of the rocks of the Animikie, it might be found that detritus from igneous rocks was an important element in their composition. Reviewing what he wrote twelve years ago as to the igneous nature of the rock from which the Mesabi ore was derived, the author expresses satisfaction with the conclusions to which he then came, and now reaffirms and strengthens them, with the new evidence.

4. A New Method of Coast Surveying is described by Dr. John Ball (Ministry of Finance, Egypt: Survey Departmental Paper, No. 21, 1911). The plan is to determine by triangulation the position of a relatively small number of stations on mountains or hills near the coast, and then by means of a theodolite and observation of the direction and depression angle to fix the position of sundry points on the coast. The necessary complex computations have been so far modified by the author that he has been able to make rapid progress with surveys, and he gives full particulars of his new method in the present work.

OBITUARY.

EDWARD WHYMPER, F.R.S.E., F.R.G.S.

Born April 27, 1840. Died September 16, 1911.

We regret to announce the death of this well-known mountaineer, author, and explorer, on September 16, at Chamonix, in the midst of the peaks, passes, and glaciers with which, for more than fifty years, he had been so familiar and had so vividly portrayed in his sketches and descriptions. In early life Edward Whymper was for many years associated with his father and brother in Lambeth as one of the well-known firm of Whymper and Sons, wood-engravers, who flourished as high-class book illustrators in the pre-process

and pre-photographic hand-camera days, when the artists for *Punch*, the *Illustrated London News*, and other papers and journals drew their pictures *direct* upon the blocks on which they were afterwards engraved; the drawings and engravings being both extensively carried out by the Whympers, father and sons, assisted by a numerous staff of wood-engravers working under their personal superintendence and instruction. The introduction of process-engraving and the rapid and less costly methods of photo-processes of all kinds have, to a very great extent, swept away the engraver and his art, and they only survive in the illustrations to such luxurious works as are but little known save to the wealthy dilettanti who desire to maintain the now almost extinct wood-engraver's art.

In 1860 Edward Whymper commenced his career as an Alpine climber, and took a commission from a London publisher to make some sketches of the great Alpine peaks. "At this time," wrote Mr. Whymper afterwards, "I had only a literary acquaintance with mountaineering, and had not even seen—much less set foot upon—a mountain. Amongst the peaks which were upon my list was Mont Pelvoux in Dauphiné. The sketches that were required of it were to celebrate the triumph of some Englishmen who intended to make its ascent. They came, they saw, but they did not conquer. By a mere chance I fell in with a very agreeable Frenchman who accompanied this party, and was pressed by him to return to the assault. In 1861 we did so with my friend Macdonald [Mr. Reginald J. S. Macdonald] and we conquered. This was the origin of my *Scrambles amongst the Alps*." In those days Alpine climbing as a sporting pastime was only just beginning to come into vogue. Mr. Whymper fell a willing victim to its fascinations. He had been attracted to Mont Pelvoux by those mysterious impulses which impel men to peer into the unknown. He next set himself to conquer the Matterhorn, which was then regarded as wellnigh insurmountable, and which appealed to him by its grandeur. Repeated failure to scale its summit only stimulated the young enthusiast to fresh endeavours, and the history of these efforts occupies a large part of his first book, *Scrambles amongst the Alps in the years 1860–69*, which first appeared in 1871. Mr. Whymper's perseverance was crowned with success in July, 1865, but the triumph was marred by a terrible disaster. The ascent of the Matterhorn is not now considered as one of unusual difficulty or danger, but the great peak avenged itself on those who first violated its virgin summit by taking a heavy toll for their achievement. On that occasion the summit had been attained, and the descent was in progress, when one of the party lost his foothold, and falling against Croz, the leading guide, knocked him over; the two following members were dragged from their steps; the guide who followed next with Whymper endeavoured in vain to save them by planting themselves as firmly as the rocks would permit, but the rope broke midway between Lord Francis Douglas and the guide Taugwalder, and the four leading members of the party fell down the almost precipitous wall of rock to the Matterhorngletscher below, a distance of nearly 4,000 feet.

During these years of *Scrambles amongst the Alps* Mr. Whymper paid two visits to Greenland, in 1867 and again in 1872. No Alpine peaks tempted him there, but at the instance of Mr. R. H. Scott, F.R.S., and entrusted with a grant from the British Association, he undertook to explore the Tertiary Leaf-beds and Coal-seams at Atanekerdluk, North Greenland, and he not only made sketches and photographs of the cliffs, but brought home a large collection of plant-remains, which was afterwards described by Professor Oswald Heer, of Zurich,[1] a part of that collection, and also the result of his later visit in 1872, being preserved in the Geological Department of the British Museum.[2]

But the achievement which brought him distinction as an explorer and gained for him the Patron's Medal of the Royal Geographical Society was an expedition in 1879–80 to Ecuador, where he made important ascents and investigations among the Great Andes of the Equator. Early in January, 1880, he attained the summit of Chimborazo, 20,498 feet, this being the highest climb hitherto placed to the credit of any mountaineer. He was accompanied by two Piedmontese guides, and camps were established at heights of 14,375 feet, 16,624 feet, and 17,285 feet. One of the guides was badly frostbitten, and all the members of the party suffered much inconvenience from mountain sickness. When, however, a second ascent of Chimborazo was successfully accomplished six months later no ill effects were felt from this cause. Nor were the climbers affected by mountain sickness when they scaled the volcano Cotopaxi, 19,613 feet high, though Mr. Whymper stayed for twenty-six hours near the crater in order to experience in his own person the action of the rarefied atmosphere on the human system. In this case, however, he and the guides were not weakened by having to contend against snow and frost, the ground on which they camped at the summit being so hot as almost to melt the indiarubber covering of their tent. The results of these researches were published in *Travels amongst the Great Andes of the Equator* (3 vols., 1891–2).

Climbers among the Alps in later years will remember Mr. Whymper by his two guide-books to Chamonix and Mont Blanc, the former of which reached this year its sixteenth edition and the latter its fifteenth edition.

For years he was well known at home as a lecturer on Alpine subjects, but even so lately as 1901–5 he explored and ascended the mountains of the 'Great Divide', the water-parting of the Rockies, where the primitive sources of the mountain streams separate, the western to join the Columbia River and the Fraser, and so ultimately reaching the Pacific, while the eastern add their contributions to the Bow River, which finally empties into Hudson's Bay. Here on Mount Field (5,000 feet) on the right bank, and Mount Stephen (8,000 feet) on the left bank, Mr. Whymper found Trilobites in the

[1] See Oswald Heer, "Contributions to the Fossil Flora of North Greenland, being a description of the plants collected by Mr. Edward Whymper during the summer of 1867": Phil. Trans. Roy. Soc., vol. clix, pt. ii, p. 445, 1870.

[2] See also Professor Nordenskiöld's "Expedition to Greenland": GEOL. MAG., Vol. IX, p. 419, 1872.